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IRON AND STEEL ENGINEER

VOL. XIII MAY • 1936 NO. V

Contents

Descaling Hot Steel Hydraulically—The Application of Water at High Velocity—by J. E. Holveck, Sales Engineer, Worthington Pump and Machinery Corporation 1

Discussion—Descaling Hot Steel Hydraulically—Discussion presented by—H. B. Mann, J. E. Holveck, M. Stone, J. H. Vohr, Howard Linn and C. L. McGranahan 10

Mill Motors and Motor Rooms—Their Ventilation in Steel Mills—by H. H. Angel, Electrical Department, Bethlehem Steel Company, Sparrows Point, Md., and C. B. Huston, Industrial Engineering Department, General Electric Company, Schenectady, New York 13

Discussion—Mill Motors and Motor Rooms—Discussion presented by—F. O. Schnure, J. H. Hucker, J. C. Reed and W. G. McDonald 27

Stockrooms For Maintenance—Their Importance in The Steel Industry—by F. O. Schnure, Superintendent, Electrical Department, Bethlehem Steel Company, Sparrows Point, Md. 29

The Great Pittsburgh Flood—How It Affected The United States Steel Corporations' Subsidiaries 31

Items of Interest 33

Convention and Exposition III

Editorial V

Index To Advertisers VI

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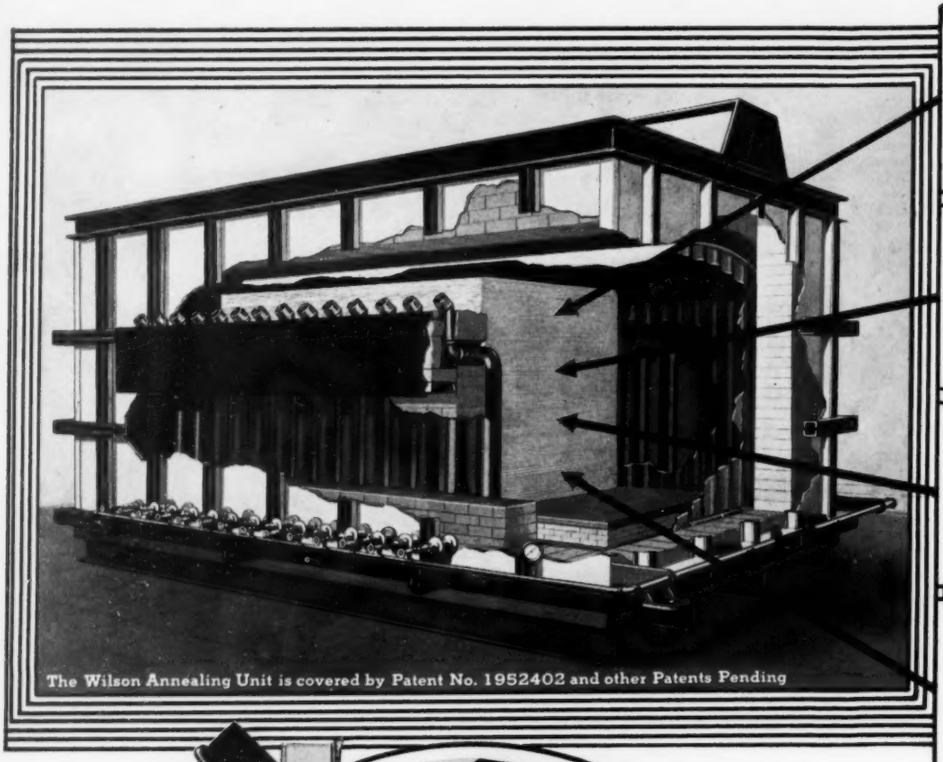

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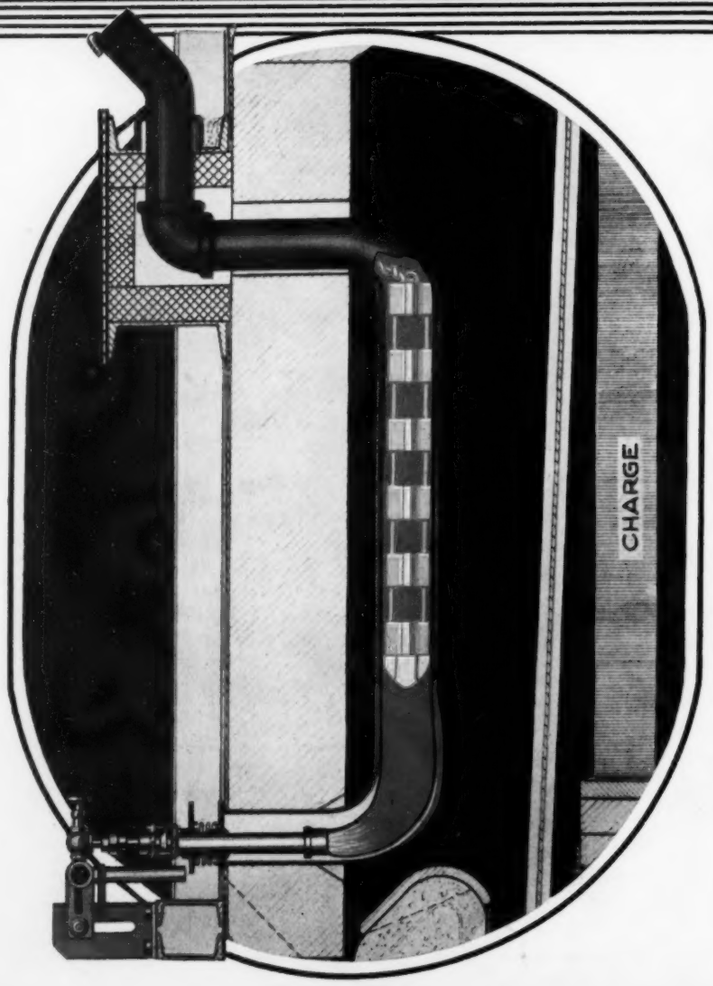

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Thirty-Second
CONVENTION and EXPOSITION

DETROIT, MICHIGAN

September 22, 23, 24 and 25, 1936

Make arrangements to attend now

PROGRAM

An unusually attractive and comprehensive technical program is now being assembled by the Papers Committee for the Annual Meeting in Detroit. It is the purpose of the Committee to have about 35 papers which will cover practically every phase of steel mill operations. In that the automotive industry, located in the Detroit area, is at the present time the largest consumer of steel, there will also be papers covering the use of steel in this industry. Supplementing the technical program will be two very interesting inspection trips. One will be to the plant of the Great Lakes Steel Corp., and the other to the steel plant of the Ford Motor Company.

EXPOSITION

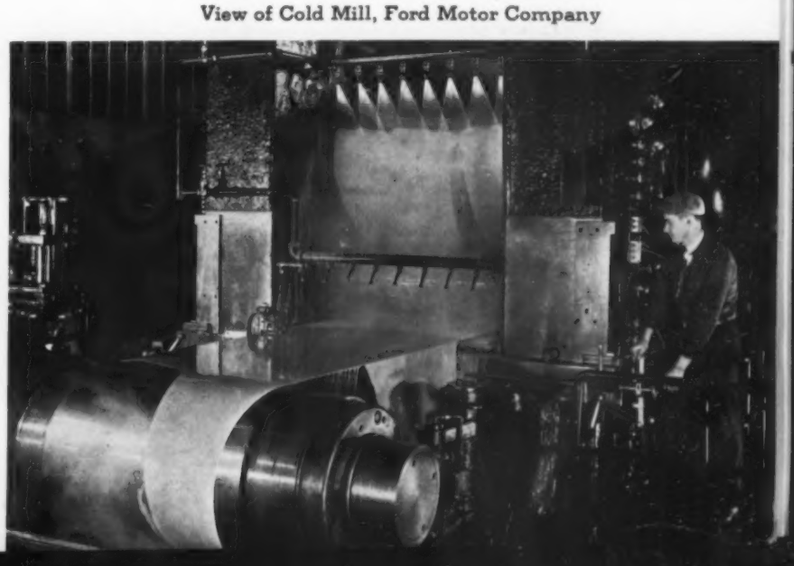
At this time of writing the Iron and Steel Exposition which will be held concurrently with the Convention promises to be one of the largest ever conducted by the Society. Approximately 128 manufacturers of steel mill equipment have contracted for all of the original space that had been laid out. In this case it has been necessary to arrange for additional space which will enable the Society to take care of all the requests.

Many exhibitors are planning unusual and instructive displays which no steel man can afford to miss while attending the annual meeting.

DETROIT STEEL PLANTS

Aerial View of Great Lakes Steel Corp.

View of Cold Mill, Ford Motor Company



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"DE-ION" LINESTARTER

A partial view of the group of more than 800 members and guests of the Association who attended the inspection trip to Carnegie-Illinois 43" Hot Strip Mill at McDonald, Ohio on April 23.

1936 Spring Engineering Conference

THE SPRING Engineering Conference which has become an annual event of the Association was held in Youngstown, Ohio, April 22nd and 23rd. The meeting was sponsored by the Combustion Engineering Division which deserves a great deal of credit for making it one of the most interesting and successful special meetings ever conducted by the Association of Iron and Steel Electrical Engineers.

The technical program included discussions on the subject of newly developed devices for the improved operation of hot and cold strip mills and also on the more general subjects of ingot heating furnaces and modern refractories in the steel industry. The various sessions were unusually well attended and the audience was very representative of the industry including representatives from executive, engineering and operating departments of the steel companies.

Improved devices and refinement of past practice are continually being developed to assist in eliminating undesirable limitation in the manufacture and rolling of steel and it is the object of such meetings to present features of this character for the consideration of the visitors. The analysis of the subjects is greatly aided by discussion and is one of the most valuable functions of the meeting.

Further interest in the program was added by a very enjoyable and inspired trip through one of the most modern hot strip mills of the country, the 43" mill of the Carnegie Illinois Steel Corporation, McDonald Works, McDonald, Ohio. The party included more than eight hundred visitors who had previously been informed of the general and special features of the mill by means of motion pictures and also a detailed descriptive article of the mill as included in the Official program.

The success of the conference was largely due to the splendid and cordial support given by the local steel company executives and their organizations which in turn stimulated the interest of the steel companies of the outlying districts and as a result the attendance was one of the largest in the history of the Association.

Furthermore Youngstown is a natural steel center with the Wheeling and Steubenville districts on the South, Pittsburgh in the East and Cleveland on the North and traditionally it has its special attraction for the men of the steel industry.

The papers presented at the meeting will be published in the forthcoming issues of the IRON AND STEEL ENGINEER for the benefit of those not in attendance at the spring conference. The subjects include the following: "Descaling Hot Steel Hydraulically"—"Circular Furnace for Ingot Heating"—"Tension Control in Cold Strip Rolling"—"Modern Refractories in the Steel Industry"—"Control and Recording of Rolling Mill Pressures" and "The Measurement of the Temperatures of Hot Moving Objects".

Keep this annual event in mind for next to our annual meeting and exposition it is the most important and valuable meeting held during the year by the Association.

INDEX TO ADVERTISERS

A

Ajax Flexible Coupling Company 82
Alliance Machine Company 84
Allis-Chalmers Manufacturing Company 81
American Air Filter Company 40
Automatic Transportation Company IX

B

The Baker-Raulang Company 68
The Bantam Ball Bearing Company 69
The Bartlett-Hayward Company 79
Brown Instrument Company 61
Bull Dog Electric Products Company VII

C

Clark Controller Company 66
The Cleveland Crane & Engineering Company 65
Columbia Electric Manufacturing Company 80
Cutler-Hammer, Inc. ..... Cover 2

D

Joseph Dixon Crucible Company 76

E

Edison Storage Battery Company 44
The Electric Controller & Manufacturing Company 45
Electric Furnace Company 71
Electric Service Supplies Company 62
Thomas A. Edison Company 44

F

Farval Corporation 86

G

General Electric Company 53–70–Cover 4

H

Hagan Corporation 75
Helwig Company 62
Hodson Corporation 39
C. H. Hunt & Son 83
Hyatt Roller Bearing Company 48

I

I. T. E. Circuit Breaker Company ..... Cover 3

J

Jefferson Electric Company 51
Johns-Manville Company 43–46–47

L

Le Carbone Company 56
Leeds & Northrup Company 38–73
Lewis Foundry & Machine Company 55
The Lincoln Electric Company 72

M

The Martindale Electric Company 77
Mesta Machine Company ..... Cover 1
Metal & Thermit Corporation 59
Morgan Construction Company 74
Morgan Engineering Company 57

N

National Carbon Company 62
National-Erie Corporation 84
New York & New Jersey Lubricant Company 82
Norma-Hoffman Bearings Corporation 60

O

Ohio Electric Manufacturing Company 76
Okonite Company 58

P

Pennsylvania Transformer Company 68
Pittsburgh Rolls Corporation 49
Poole Foundry & Machine Company 64
Pyle-National Company 42

R

Reliance Electric & Engineering Company 78
Republic Flowmeters Company 54
Rockbestos Products Corporation 63
Rowan Controller Company 80

S

S. K. F. Industries, Inc. 41
B. F. Sturtevant Company 85
Surface Combustion Company VIII

T

The Thompson Electric Company 77
The Timken Roller Bearing Company 52
The Tool Steel Gear & Pinion Company 50
Trico Fuse Manufacturing Company 67

U

Union Carbide & Carbon Company 62
United Engineering & Foundry Company 37

W

Wean Engineering Company, Inc. II
Westinghouse Electric & Manufacturing Company IV
Worthington Pump & Machinery Corporation X

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DESCALING HOT STEEL HYDRAULICALLY

THE APPLICATION OF WATER AT HIGH VELOCITY

By J. E. HOLVECK, Sales Engineer,
Worthington Pump and Machinery Corp.
PITTSBURGH, PA.

Paper presented before the A. I. & S. E. E. Spring Engineering Conference, Youngstown, Ohio, April 22, 23, 1936

▲ THE application of water at high velocity has been universally accepted as the best method of removing scale during the process of rolling hot steel. This important progress in the manufacture of various commercial steels, particularly strip, has resulted in higher quality, more accurate gages, and better surface finish. The benefits derived from this process have been so satisfactory that descaling is being rapidly applied to other steel products such as sheet bar, plate, skelp, merchant bar and seamless tubing.

The first consideration in a hydraulic descaling system is a nozzle with the proper shape of orifice which will produce a satisfactory jet, converting the selected available pressure into an efficient impinging force of sufficient magnitude to break the scale.

This impinging force, which is the result of mass and velocity, or water and pressure, first breaks the scale, after which the water, being in continuous contact with the steel, washes the loosened scale off the surface.

In the early application of water for descaling, round orifices consisting of small drilled holes in the header pipe, were used. The jet resulting from this orifice was found to produce only about 65% of the impinging force of the well designed nozzle which has little or no contraction and a small amount of friction loss. The round orifice also forms a round jet varying in density from the center to its outer periphery.

A rectangular orifice was the first development in a more efficient nozzle. After extensive experiments, the Worthington Pump and Machinery Corporation has developed an improved nozzle which has, among other features, an elliptical orifice which not only produces a maximum impinging force, but delivers this force uniformly throughout the full length of the jet. This nozzle is illustrated in Figures 1a, 1b, 1c, 1d, and 1e.

Figure 1a shows the elliptical orifice in the one piece stainless steel hardened disc. This disc is separate from the cap and held in the cap by means of a self-locking taper.

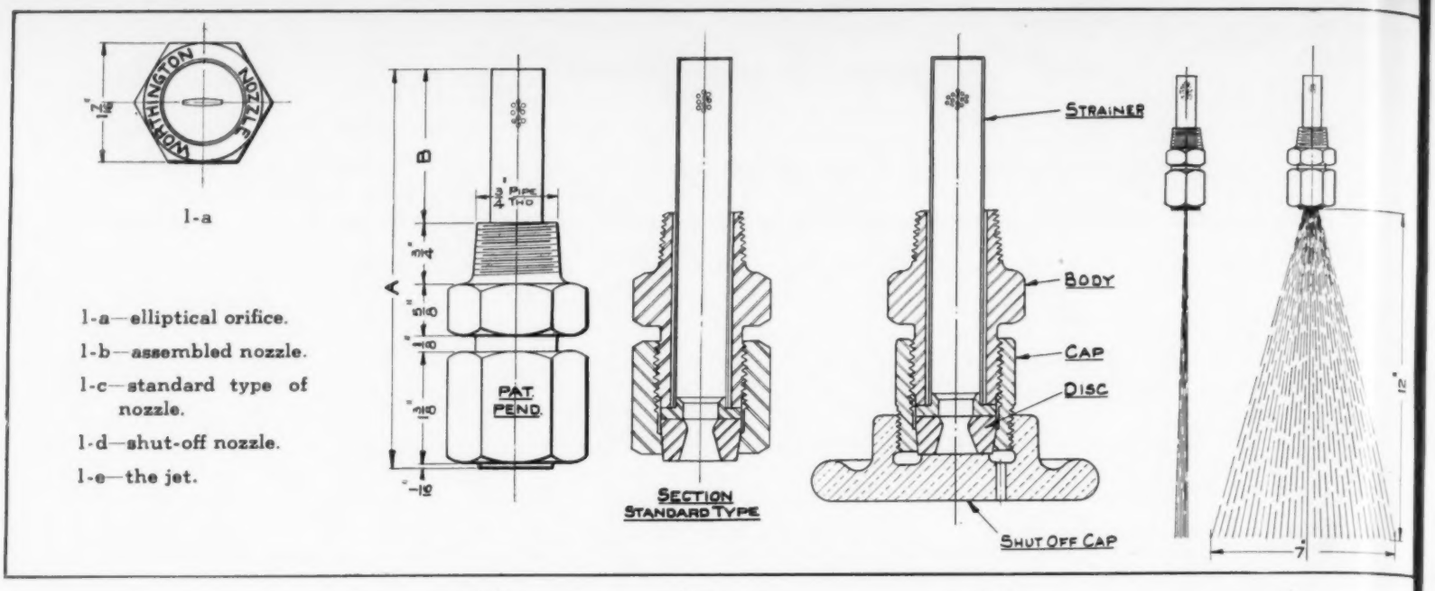
Figure 1b illustrates the compactness of the assembled nozzle, giving all pertinent dimensions.

Figure 1c, a standard type of nozzle with the removable strainer, is shown in cross section. Provision should be made for supplying clean water by means of a main strainer such as a sand filter, self-cleaning strainer, or a settling tank. The nozzle strainer furnished and illustrated is to prevent clogging of the disc by the occasional foreign matter which may pass through the main strainer, or other solid matter developed between the main strainer and the nozzle such as pipe scale, algae, packing from pumps and valves, etc.

Figure 1d shows a recent development in an improved type of shut off nozzle having a blank cap which can be quickly screwed on and off by hand.

This shut off arrangement does not require the use of a wrench and therefore provides a means for quickly closing and opening the nozzles by hand. This is of considerable advantage when the use of a wrench is inconvenient or even in some cases impossible on account of limited space and inaccessibility. This is

J. E. HOLVECK



1-a

1-a—elliptical orifice.
1-b—assembled nozzle.
1-c—standard type of nozzle.
1-d—shut-off nozzle.
1-e—the jet.

1-b 1-c 1-d 1-e

mainly true of the nozzles located in the bottom nozzle header.

Since it is required that the orifice in the nozzle be set at a fixed angle, it is important not to disturb this angle once they are adjusted, otherwise the continuity of the jets across the sheet may be broken, thereby causing scale streaks. The blank cap for this nozzle is screwed on and off without changing the original position of the orifice.

Figure 1e illustrates the form and divergence of the jet, the length of which is 7″ at a distance of 12″ from the face of the nozzle.

TABLE 2

GALLONS PER MINUTE DISCHARGE

Disc. No.	Pressure (pounds per sq. inch)					
	500	600	700	800	900	1000
1	24.1	26.3	28.5	30.4	32.3	34.0
2	18.05	19.75	21.4	22.8	24.2	25.5

The Worthington nozzle is furnished in two different sizes of orifices, designated as disc numbers 1 and 2,

TABLE 3

NOZZLE AND STRAINER DATA

Manifold Pipe Size	A Inches	B Inches	C Inches	Hole Diameter Inches	Holes per Sq. Inch	Free Strainer Area Sq. Inches
4″ extra strong	$5\frac{11}{16}$	$2\frac{3}{4}$	$5\frac{1}{4}$	.027	400	2.7
3″ extra strong	$4\frac{11}{16}$	$1\frac{3}{4}$	$4\frac{1}{4}$	.027	400	2.2
$2\frac{1}{2}$″ extra strong	$4\frac{3}{16}$	$1\frac{1}{4}$	$3\frac{3}{4}$	.027	400	1.95

all other dimensions being the same. Table No. 2 gives the capacities for given pressures. For any other pressure, the capacity varies as the square root of the pressure.

Table No. 3 gives the strainer length and strainer areas for different manifold pipe sizes.

With the foregoing data available for selecting a suitable nozzle, the next step is to consider the two important factors of flow and pressure as they combine to produce the necessary impinging force for descaling. It is the intent of this article to offer practical suggestions for the use of high pressure water for satisfactory descaling of hot steel; accepting certain facts already established in a previous article by the writer on this subject (Iron & Steel Engineer Aug. 1931) and proven by experience in existing installations.

All the factors entering into a successful descaling system may be briefly outlined as follows:

G = Gallons per minute flow of the jet per inch width of the slab where the water comes in contact with the steel. This value will be taken as a measure for determining the degree of descaling which, with a given pressure, varies directly as this value G.

G varies as the product of the orifice area and the square root of the pressure. With a given pressure this value also varies directly as the area of the orifice.

P = Pressure in pounds per square inch at the nozzle or orifice. It has been determined that with an orifice of restricted area, the maximum efficiency and greatest degree of descaling is obtained between pressures of 900 and 1000 pounds per square inch. Any increase beyond this pressure must be accompanied by an increase in area of the orifice. This would increase the flow beyond values actually required, resulting in unnecessary cooling of the steel. Other means for increasing the degree of descaling without changing the pressure, is to simply increase the value G by methods which will be described later.

P varies directly as the square of G. It is recommended that 1000 pounds pressure be accepted as the most satisfactory. This pressure, with the selec-

tion of nozzles and their arrangement offers a combination for any degree of descaling hot steel that may be required.

F = Impinging force in pounds per inch width of the slab where the water comes in contact with the steel. This force varies directly as the product of G and the square root of P.

Another factor to be considered is that of the cooling effect of the water on the steel. Cooling of the hot steel varies directly as the value of G. The selection of G should be of such magnitude to give just the descaling required. The increase in pressure to 1000 pounds was a natural step in descaling since this higher pressure eliminated excessive cooling in the early reduction passes.

The application of the jet produced by the nozzle, is shown in Figure 4. The maximum impinging force occurs with the jet directed at an angle of 90° with the slab. It is recommended, however, that a slight inclination of about 15° be used. This slight angle detracts little from the impinging force and has an important advantage of directing the full flow of the jet in one direction to wash the loosened scale off the slab and away from the rolls.

Figure 5 shows a number of nozzles arranged to descale on the top side of a hot slab. The arrangement for the bottom side would be the same. The nozzles are located on centers "a" with the orifice set at an angle "g" so that the hydraulic jet, where it comes in contact with the surface of the steel, provides for a minimum overlap "b" with the adjacent jets. This allows for a continuous jet across the width of the slab.

In the elevation of Figure 5, the face of the nozzle is located at a distance "e" from the surface of the slab. The overlap of the jets in the vertical plane, extend to a height "c". To insure against a break in the continuity of the jet across the width of the slab, the selection of centers should be such as to provide an overlap of greater height than the slab will raise above the table.

Dimension "u", a unit measurement, represents any one inch in the width of the slab, taken at right angles to the direction of motion of the slab. This measurement is used in evaluating the impinging force F in terms of gallons per minute G. The greater the angle "g" induced by closer centers, the greater the impinging force F and gallons per minute G.

Since G varies directly as F, with a given pressure, G will be used in this article for comparing the degree of descaling between two or more arrangements of nozzles. The reason for this is that G is more easily determined from the known gallons per minute discharge of the nozzles.

The value G used in this article, is obtained by dividing the gallons per minute discharge of the nozzle by the nozzle centers. This is a close approximation of the actual value and will answer its adoption for comparative purposes.

With a given pressure the degree of descaling varies directly as the value G.

Table 6 shows the value of G at 1000 pounds pressure for the No. 1 and No. 2 discs for various centers "a" and distances from the surface of the slab "e". A minimum overlap of $\frac{5}{8}''$ is assumed in all cases.

It will be noted from this table, with dimension "e" fixed, that G may be varied by changing the nozzle centers "a" and turning the orifice to the corresponding angle "g".

For example, with $6\frac{1}{4}''$ centers and the orifice set at an angle of 10° with a No. 1 disc, the value G is 5.45 gallons per inch; should it be required to increase the degree of descaling say 20%, then the value G required is 6.54 gallons per inch, which corresponds very closely to 6.51, the value in the table corresponding to $5\frac{1}{4}''$ centers with the orifice set at an angle of 33°. Should it be required to reduce the degree of descaling, the use of a No. 2 disc on $6\frac{1}{4}''$ centers and same angle "g" gives a value of 4.1 gallons per inch which is a decrease of 25% in the degree of descaling.

For heights "e" less than 12", the values of "b", "f", and "g" in columns 8, 10, and 11, are located in the table opposite the maximum centers which may be used for the height selected. For example—for a height "e" of 11" the maximum centers which may be used are $5\frac{3}{4}''$; for a height of 10", the centers should not be greater than 5" etc.

Since the values "G" are based on the centers "a", then these values "G" are given in the table opposite the chosen centers regardless of the height "e". Any assembly arrangement for a given height "e" may be used from its maximum centers to the minimum. For example—with a height "e" of 11", any centers may be used from $5\frac{3}{4}''$ to $2\frac{1}{2}''$, depending upon the value G required.

With the two sizes of discs, a wide range of descaling values are possible from 4.1 to 13.6 gallons per minute per inch.

With a pressure of 1000 pounds per square inch, we believe sufficient impinging force can be obtained with values for G from 4 to $6\frac{1}{2}$ gallons per minute. On some mills higher values are used and in most cases it will be found that these higher values are applied in the finishing passes of the mill which leads the writer to believe that the purpose is for cooling rather than descaling. If this is so then low pressure water would be more economical to use.

DETERMINING THE WATER DEMAND

Practically all descaling requirements have the same variable water demand characteristics. There may be a few cases where the water demand is constant but these are the exception. In this paper we will consider hydraulic descaling and methods for determining satisfactory equipment for a 92" continuous hot strip mill. For determining the water demand for any other type or size of mill, this same procedure may be followed.

The selected pressure of 1000 pounds per square inch is the pressure at the pumps. The actual pressure

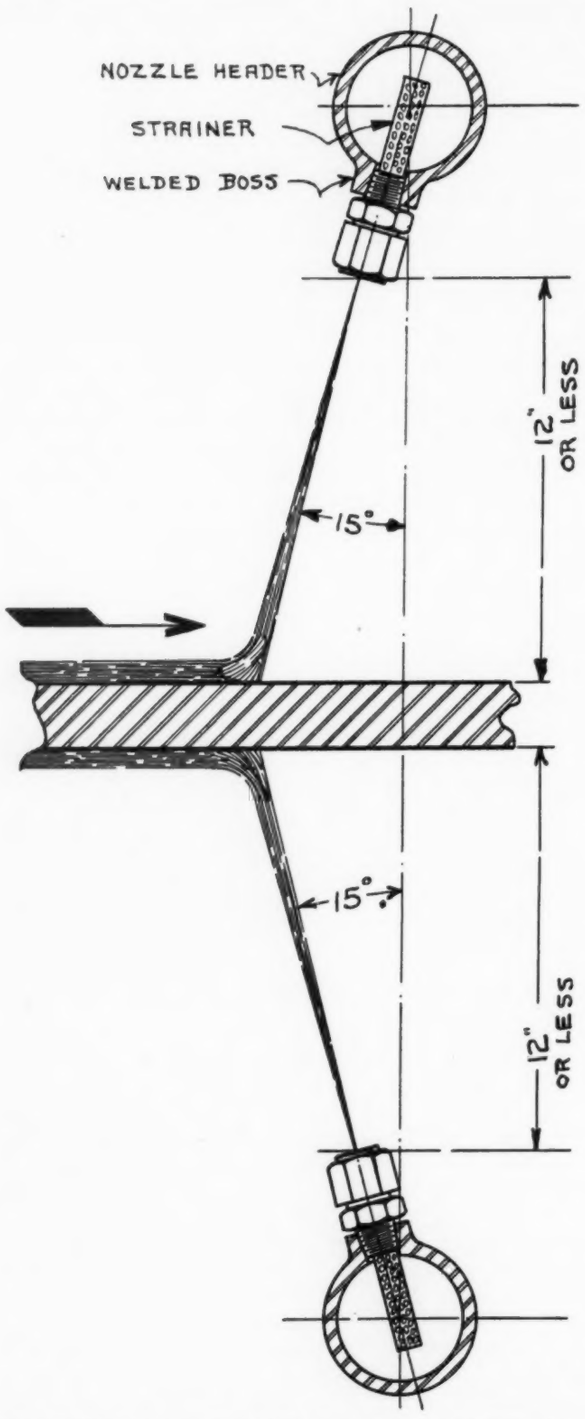


Fig. 4—The application of the jet produced by the nozzle.

at the nozzles will be somewhat less depending upon the loss due to friction through the pipe line and operating valves. Since it is customary to install the pumps close to the mill, the friction loss, with the proper selection of pipe sizes and type and size of operating valves, should not exceed 50 lbs. per square inch. In this article the friction loss will be neglected as the loss in the value of "G", for even this drop in pressure would amount to only 2½% of the figures given.

Figure 15 illustrates the continuous hot strip mill with descaling locations as shown.

There are five top and bottom descaling locations shown for this mill. These are not all used at the same time but varied to meet the particular needs of the material in process of rolling. In order to insure sufficient pump capacity, the maximum water demand is based on the five pairs of water jets as shown. The descaling values allowed at each location on a basis of 1000 pounds pressure and expressed in the value G or gallons per minute per inch are as follows:

Following the scale breakers SB-1 and SB-2 = 5.45 gal. per in.

Preceding the roughing stands Nos. 2, 3, and 4 = 4.1 gal. per in.

These values are close to those now being used on present strip mills. It will be noted that these values allow for the greatest degree of descaling at scale breakers SB-1 and SB-2 and lower values at the roughing stands. In some cases, only one pair of jets are used as at No. 2 followed by top jets at No. 3 and No. 4, or this latter location may be omitted entirely. With an excess of water demand allowed for at locations No. 2, No. 3, and No. 4, additional water can be utilized at SB-1 and SB-2 if desired up to a value of 7½ gallons per inch.

Diagrams in Figure 7 represent the time cycle in seconds of the respective water jets "T1", "T2", "T3", etc. for both direct and cross rolling per slab, as the slab passes each descaling location throughout the mill. "T" is taken equivalent to the time of the slab in the pass of its respective stand plus two seconds allowance for delay. The intervals of time of the slab in moving from one descaling location to the next is indicated by "t1", "t2", "t3", etc.

Figure 8 illustrates the relation between the time cycle of the respective water jets "T" and the time interval between the consecutive slabs indicated by "Ta".

For estimating the water demand of this mill the values taken for "t" and "T" are shown in the diagrams. The time interval between slabs "Ta" is taken for three different cycles of 50, 60, and 70 seconds corresponding to 72, 60, and 52 slabs per hour.

The maximum width for direct rolling for this mill is 46″ and all finished sheet or strip over this width and up to the maximum of 86″ wide is cross rolled in the spreader stand No. 1.

Figure 9 illustrates the nozzle arrangement for descaling on the top and bottom of the slab or strip. The nozzle centers of 6¼″ would be the same for all locations, however, for locations at SB-1 and SB-2, No. 1 discs are used and for No. 2, No. 3, and No. 4, No. 2 discs would be applied. This arrangement gives values for G as previously specified. The outer nozzles should be the shut off type illustrated in Figure "1d" which permits these nozzles to be shut off when rolling narrow widths.

With the nozzle header assembly shown in Figure 9, the rate of flow at locations SB-1 and SB-2 will be 952 and 544 G. P. M. for 86″ and 46″ wide respectively. For locations No. 2, No. 3, and No. 4, the rate of flow will be 714 and 408 G. P. M. for 86″ and 46″ wide respectively. The table accompanying figure 9 gives the rate of flow for different widths from 34″ to 86″ for the two sizes of discs.

Table 10 gives the water demand for various widths of the slab, for cross rolling and direct rolling, with excess nozzles closed and with all nozzles open, for the mill with all the descaling locations shown in Fig. 15 and for the time cycles shown in Figures 7 and 8.

To meet the water demands of this mill, we have selected two pumps each having a capacity of 900 G. P. M. at the normal pressure of 1000 pounds per sq. in. For these conditions one pump will take care of the water demand and the other unit becomes a spare, providing all excess nozzles are closed as recommended. Should this recommendation not be carried out, then both pumps would be operated for this maximum condition which would occur when rolling slabs direct.

It is shown that considerable economy of water and power can be realized by taking advantage of the means afforded for shutting off the nozzles that are not required. The table shows, as in condition 1, that the maximum average demand of 1404 G. P. M. is reached when rolling direct for 46″ wide with all nozzles open for the maximum width of 86″. However, should all excess nozzles be closed, then the maximum demand is only 800 G. P. M. as shown in condition 2. This saving represents an economy at the rate of 340 KW per hour for reciprocating pumps and 415 KW for centrifugal pumps. (See table 14.)

The average demand of 696 G. P. M. for condition 3 is the maximum water demand when cross rolling for the greatest width of 86″.

Fig. 5—A number of nozzles arranged to descale on the top side of a hot slab.

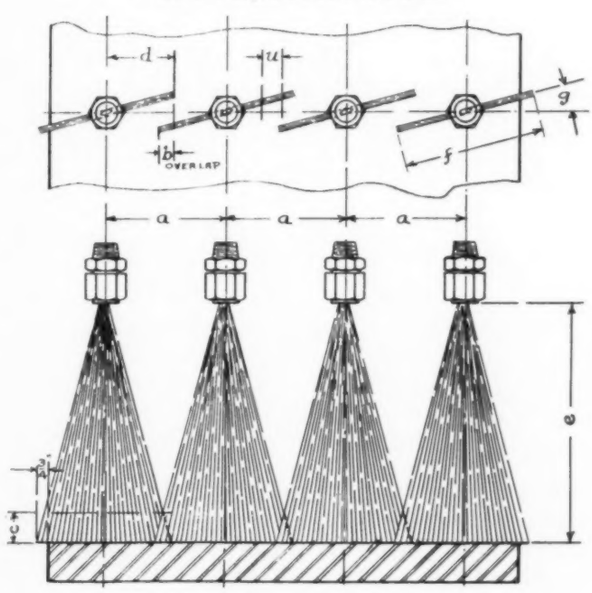


TABLE 6

ASSEMBLY DATA FOR WORTHINGTON NOZZLES

SEE FIGURE 5

For 12″ Height "e"							Data for Maximum Nozzle Centers for Heights "e" Other Than 12″				G GPM Per Inch "u" at 1000 Lbs. Pressure	
a	b	c	d	e	f	g	b	e	f	g	No. 1 Disc	No. 2 Disc
6¼	5/8″	1.1	3 7/16	12	7	10°					5.45	4.1
6	5/8″	1.12	3 5/16	12	7	22°					5.67	4.25
5¾	5/8″	1.16	3 3/16	12	7	25°	5/8″	11″	6½″	11°	5.91	4.45
5½	5/8″	1.25	3 1/16	12	7	29°	5/8″				6.21	4.65
5¼	5/8″	1.3	2 15/16	12	7	33°	5/8″				6.51	4.86
5	5/8″	1.35	2 13/16	12	7	37°	5/8″	10″	5 7/8″	16°	6.81	5.1
4¾	5/8″	1.38	2 11/16	12	7	40°	5/8″				7.15	5.38
4½	5/8″	1.42	2 9/16	12	7	43°	5/8″	9″	5¼″	11°	7.55	5.68
4¼	5/8″	1.47	2 7/16	12	7	46°					8.0	6.0
4	5/8″	1.6	2 5/16	12	7	49°	5/8″	8″	4¾″	14°	8.5	6.30
3¾	5/8″	1.7	2 3/16	12	7	51°	5/8″				9.1	6.8
3½	5/8″	1.8	2 1/16	12	7	54°	5/8″				9.7	7.3
3¼	"5/8	1.9	1 15/16	12	7	56°	5/8″	7″	4⅛″	20°	10.4	7.85
3	"5/8	2.1	1 13/16	12	7	59°	5/8″				11.3	8.5
2¾	5/8″	2.2	1 11/16	12	7	62°	5/8″	6″	3¾″	15°	12.4	9.3
2½	5/8″	2.3	1 9/16	12	7	64°	5/8″				13.6	10.2

Table 6 shows the value of G at 1000 pounds pressure for the No. 1 and No. 2 discs for various centers "a" and distances from the surface of the slab "e". A minimum overlap of "5/8" is assumed in all cases.

Figure 11 shows the water demand chart for the maximum possible service as indicated by condition 1 in table 10. The average pump capacity required is 1404 G. P. M. and this necessitates the use of the two 900 G. P. M. pumps each delivering 78% of their rated capacities. This condition occurs when rolling direct for 46″ wide sheet but with all nozzles open for 86″ wide. With all the unnecessary end nozzles closed off as they should be, then the water demand is considerably less as illustrated by the chart in Figure 12.

The accumulator demand is represented by the full shaded areas above the line representing the capacity of the pumps.

The chart in Figure 12 shows the water demand for direct rolling for 46″ wide with all unnecessary nozzles shut off as indicated by condition 2 in table 10. This condition requires 89% of the rated capacity of one pump and represents a saving in power at the rate of 340 and 415 KW per hour for the reciprocating and centrifugal pumps respectively.

The accumulator demand in this case is approximately the same as in Figure 11.

It is recommended that the accumulator displacement required be based on the volume represented by the full shaded areas above the line representing the pump capacity.

In the two demand sharts shown the peak demand in gallons per second is 88% above the average. This

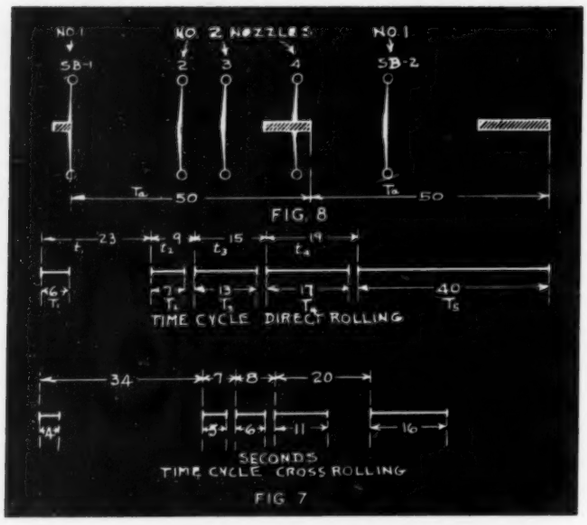


Fig. 7 shows diagrams representing the time cycle in seconds of the respective water jets "T1", "T2", "T3" etc. for both direct and cross rolling per slab.

Fig. 8 illustrates the relation between the time cycle of the respective water jets "T" and the time interval between the consecutive slabs indicated by "Ta".

peak for some types of mills is as much as 300% above the average. These conditions in the water demand make the use of an accumulator essential. It is readily seen that without an accumulator, the pump would have to be selected for the peak demand necessitating a larger unit over one based on the average demand and an accumulator. Furthermore, without an accumulator a centrifugal pump would be subject to more severe operating conditions and a reciprocating type of pump would be inadvisable.

ACCUMULATOR

The hydro pneumatic type of accumulator illustrated in Fig. 15 has been found most suitable for these conditions and is recommended for this service. It consists of a welded steel closed pressure vessel which under the normal operating pressure of 1000 pounds contains a volume of trapped compressed air of not less than two thirds its volume and one third its volume of water.

Its function is based on the expansion of the compressed air between a high and a lower pressure, in accordance with the basic law of $pV = Pv$, resulting in the displacement of a volume of water equal to the volumetric expansion of the compressed air. This condition occurs when the water demand exceeds the capacity of the pump as illustrated in the charts, Figures 11 and 12. When the water demand is less than the capacity of the pump then the displaced volume of water is replaced by the pump accompanied by an increase in pressure and reduction in air volume corresponding to their original value and relation.

The size of the accumulator in volume, with a given ratio of air and water should be such as to take care

RATE OF FLOW THROUGH BOTH HEADERS FOR VARIOUS WIDTHS

Width Slab	No. Nozzles	Size Nozzles	GPM	GPS
86	28	#1	952	15.9
		#2	714	11.9
74	24	#1	816	13.6
		#2	612	10.2
62	20	#1	680	11.3
		#2	510	8.5
46	16	#1	544	9.06
		#2	408	6.8
34	12	#1	408	6.8
		#2	306	5.1

of the peak demands on a pressure variation of 50 to 100 pounds in a 1000 pound system.

For the conditions of this mill an accumulator is selected having a total volume of 2500 gallons which with a ratio of two thirds air and one third water will allow for a pressure variation not exceeding 50 pounds per square inch.

The advantages of an accumulator and particularly the hydro pneumatic type may be briefly stated as follows:

Enables the selection of a smaller pump based on the average demand instead of the peak demand.
Provides for better economy in power consumption.
Provides for a more even and constant pressure in the system.
Provides a means for absorbing shocks to the system caused by closing of the operating valves.
Reduces the number of times at which a centrifugal would operate at shut off.

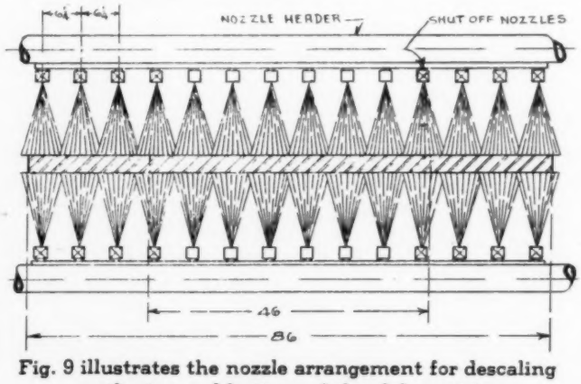


Fig. 9 illustrates the nozzle arrangement for descaling on the top and bottom of the slab or strip.

Having no moving parts, there is practically no maintenance expense.

The curves in Figure 13 represent the input power in KW for one 900 G. P. M. centrifugal and one 900 G. P. M. reciprocating pump selected for this 92" continuous mill. This shows the KW for each type for a varying demand from zero to 100%.

TABLE 10

AVERAGE WATER DEMAND ON 92″ CONTINUOUS MILL FOR VARIOUS WIDTHS

				EXCESS NOZZLES CLOSED				ALL NOZZLES OPEN				
	Rolling Width Inches	Total Time "T", Per Slab Seconds	Gallons Per Slab	Time "Ta" Between Slabs Seconds	Average Demand G P M	Number Pumps Operating	Per Cent of Each Pump Capacity	Gallons Per Slab	Time "Ta" Between Slabs	Average Demand G P M	Number Pumps Operating	Per Cent of Each Pump Capacity
CROSS ROLLING	86	42	514	50	696	(3)1	77					
				60	580	1	64					
				70	496	1	55		50	696	1	77
	74	42	441	50	600	1	67	514	60	580	1	64
				60	497	1	55		70	496	1	55
				70	426	1	47					
	62	42	366	50	495	1	55					
				60	413	1	46					
				70	354	1	39					
DIRECT ROLLING	46	83	610	50	800	(2)1	89					
				60	668	1	74					
				70	572	1	64		50	1404	(1)2	78
	34	83	459	50	600	1	67	1068	60	1170	2	65
				60	502	1	56		70	1000	2	56
				70	428	1	47					

(1), (2), (3) } Refer to Article

Table 14 gives the power consumption for the three conditions of water demand, (1), (2), and (3) indicated in table 10. For condition (1) two pumps would be in service, each operating at 78% of their capacity. The difference in power consumption between the two types of pumps per year for condition (1) will be 900,000 KW hours which at a six mill rate represents a saving of $5400.00 in favor of the reciprocating units. If we assume 50% operation for each of the two conditions (1) and (2), then the saving in power will be $4050.00 per year.

These figures show the economy in shutting off unnecessary nozzles as represented by the difference of 415 KW for conditions (1) and (2) in table 14. If the mill operated for a period of 10 hours on 46″ wide but with all nozzles open for 86″ wide, then the excess power consumed would be 4150 KW hours per day which at a 6 mill rate would represent a loss of $24.90. To effect this saving it would be well worth the effort to see that the excess nozzles are shut off for this condition.

Figure 15 covers a schematic layout of all the equipment involved in a complete system for supplying pressure water for descaling on the 92″ continuous strip mill taken as an example in this paper. This arrangement and layout would apply also to other sizes of mills or other types involving the use of a hydro pneumatic accumulator. Only the size of the various equipment would be affected to meet the different water demand.

It is not the writer's intention in this paper to enter into a discussion of the relative merits of the two types of centrifugal and reciprocating pumps for this service. Each application of hydraulic descaling requires a thorough study of all phases affecting the selection of the proper type of equipment. The most important is the character of the water demand which influences not only the proper size of the pump but also the type of pump to be selected—whether centrifugal or reciprocating. Also one of the main factors of consideration is the difference in power consumption against which must be weighed the difference in first cost, floor space, installation cost, maintenance and amortization.

In general it will be found that in cases where the average water demand calls for large units operating continuously close to 100% capacity, that the centrifugal type of pump will be found most suitable. At the smaller capacities and more intermittent demands, the reciprocating type of pump will be found more favorable.

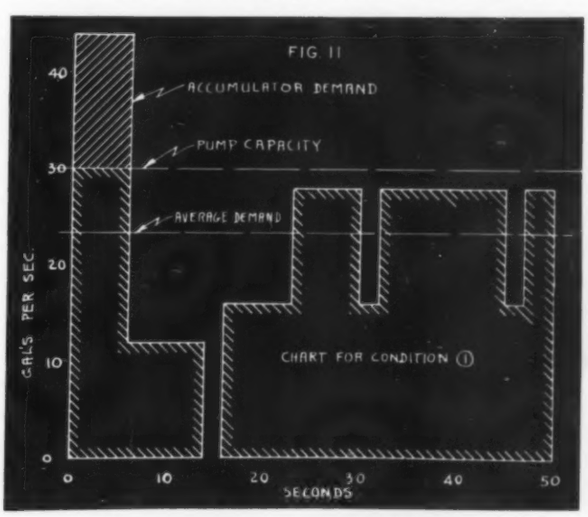
The general arrangement of pumps and auxiliary equipment as shown in Figure 15, is practically the same for either type of pump, with the exception of the necessary bypass required for the centrifugal unit to insure against overheating when operating at shut off.

CENTRIFUGAL PUMP

Where the conditions favor the centrifugal pump, then the selection of the proper type should receive careful consideration. The water demand as shown in the charts indicates a varying flow from the pump with sudden changes of capacity. These intermittent changes in pumping requirements cause shocks in the pump (very much greater without an accumulator) tending to upset the axial and radial hydraulic balance of the pump. If this balance depends upon a single breakdown, such as a balancing disc or drum, then a severe axial load is thrown on the thrust bearing.

The Worthington Pump and Machinery Corporation offers for this variable demand, a balanced volute

Fig. 11—The water demand chart for the maximum possible service as indicated by condition 1 in Table 10.



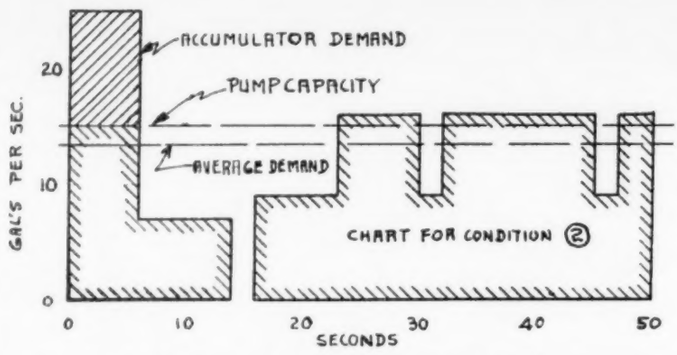


Fig. 12—This indicates the water demand with all the unnecessary end nozzles closed.

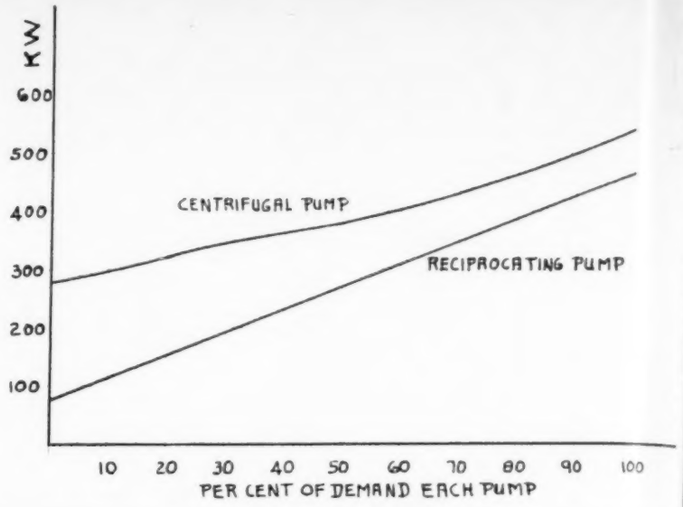


Fig. 13—These curves represent the input power in KW for one 900 G.P.M. centrifugal and one 900 G.P.M. reciprocating pump selected for this 92" continuous mill.

pump having opposed impellers of such design that the pressures of the successive stages act in an axial counterbalancing arrangement against each other, without resorting to any outside balancing device. Another feature of this design is the practical elimination of radial thrust by means of alternately staggering the volutes.

This pump has also outside interstage loop passages which allow for an extremely small diameter closely bolted casing with a minimum number of internal parts. A number of installations have proven this pump admirably adapted for this severe service.

The automatic bypass arrangement is shown in Figure 15, being indicated by item (O). There are a number of different arrangements but the one shown consists of a two way type of valve operated by low pressure service air and controlled by a solenoid operated air pilot valve. The valve is automatically manipulated by one of the pressure regulators (H) connected to the air side of the accumulator. When the pressure reaches that corresponding to the shut off or point of no discharge, the valve is automatically opened and the pump discharges through this bypass valve. The amount of flow through the bypass is determined by the orifice through the orifice nipples (U) inserted in the line. With one pump in service, the bypass flow goes through one nipple and with two pumps in service, both nipples are utilized. The amount of water bypassed is approximately 30 G. P. M per hundred brake horsepower developed by the pump at shut off.

Another bypass arrangement "W", shown in Figure 15 has a dual purpose of bleeding the necessary water for protecting the pumps and at the same time maintains a small flow of water through the nozzles, keeping the nozzle headers full of water.

Without this bypass, the water drains out of the top header through the nozzles when the operating valve (E) is closed. When this valve is opened, a considerable shock takes place in building up the pressure suddenly in the top leader, which shock is eliminated when the piping is kept full.

An orifice nipple indicated by (X) is inserted in this bypass to regulate the amount of water bypassed.

In addition to either one of these bypass arrangements, each pump should be equipped with a thermostat relay switch which is operated by means of a thermal element connected to the pump casing. Should the bypass fail to function for some reason, then the pump would be protected by being shut down through a temperature rise in the pump casing.

RECIPROCATING PUMP

Where the conditions favor the reciprocating type of pump, the choice lies in a duplex double acting, triplex double acting, or a triplex single acting. The double acting types, either duplex or triplex are favored in the larger units and the triplex in the smaller sizes.

The main details of consideration in the reciprocating pump are those affecting maintenance such as valves, plunger packing, plungers, lubrication, drive, bearings, and control of the pump for the variable demand. Worthington offers for this particular application the latest designs and use of improved materials for all wearing elements, thus insuring the lowest possible maintenance expense.

The pump is controlled by means of one of the pressure regulators (H). Worthington offers an unloading device operated by the pressure regulator whereby the suction valves of the pump become inoperative when the unloading pressure is reached. Under this condition the pump operates only on the suction pressure at a nominal power consumption of between 10% and 15% of the normal load. The pump continues to operate unloaded as long as there is no water demand. When there is a demand on the system, the pump is again loaded at a predetermined pressure drop corre-

TABLE 14

POWER CONSUMPTION AND COMPARISON BETWEEN CENTRIFUGAL AND RECIPROCATING PUMPS

Condition as Indicated in Table 10	Average Demand G P M	Number of Pumps Operating	Per Cent of Each Pump Capacity	Rate of KW Input Centrifugal Pump	Rate of KW Input Reciprocating Pump	Difference in KW Input Per Year 20 Hrs. Per Day 300 Days Per Year	Difference in Dollars Per Year at 6 Mill Rate
(1)	1404	2	78	910	760	900,000	$5400.00
(2)	800	1	89	495	420	450,000	2700.00
(3)	696	1	77	452	375	462,000	2772.00

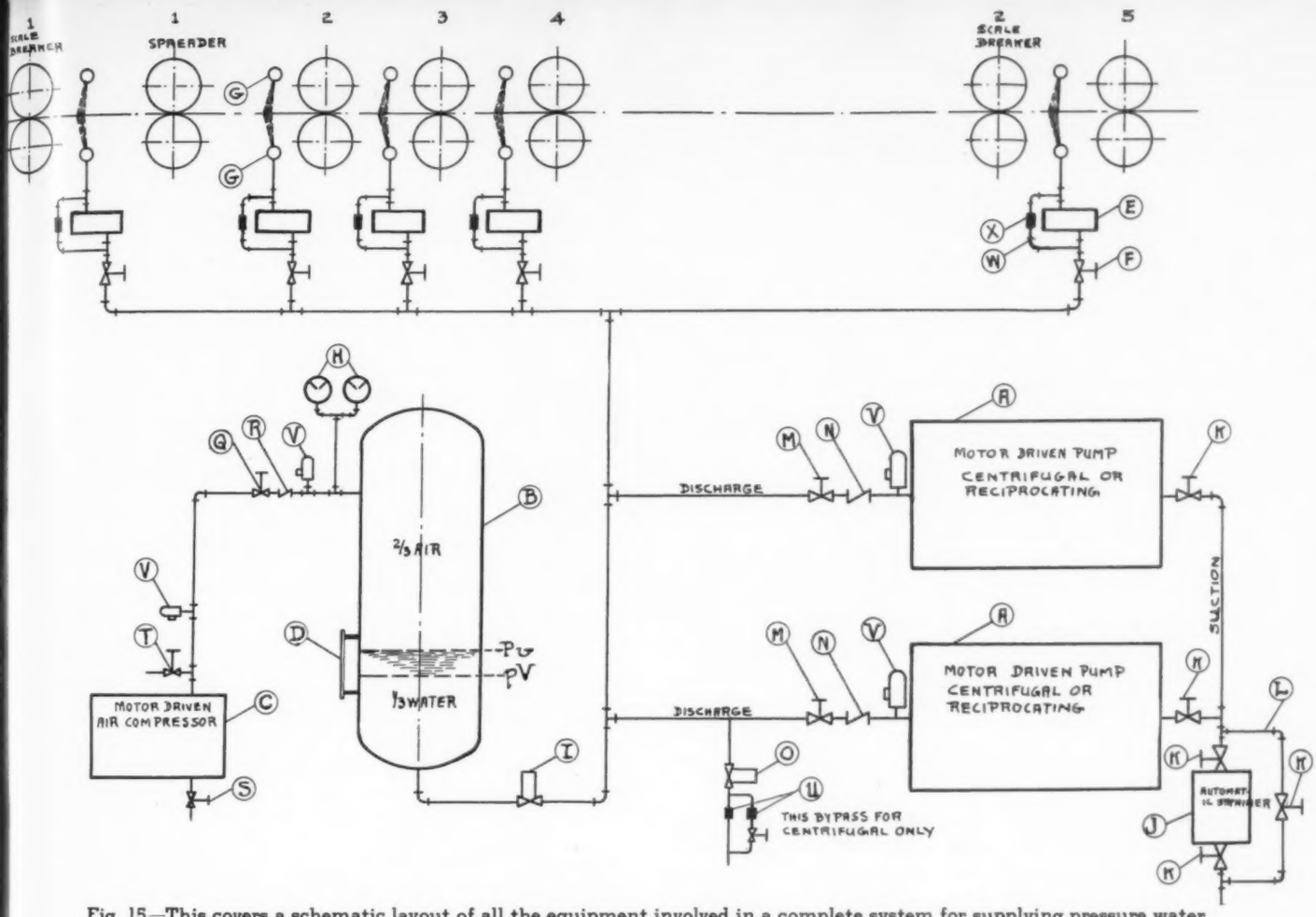


Fig. 15—This covers a schematic layout of all the equipment involved in a complete system for supplying pressure water for descaling on the 92″ continuous strip mill taken as an example in this paper.

A—Pump and Motor	G—Nozzles and Header	M—Stop Valve	T—By Pass for Starting
B—Accumulator	H—Pressure Regulators	N—Check Valve	U—Orifice Nipple
C—Air Compresser	I—Automatic Stop Valve	O—Automatic By Pass	V—Relief Valves
D—Gauge Glass	J—Automatic Strainer	Q—Stop Valve	W—By Pass
E—Two way automatic valve	K—Stop Valves	R—Check Valve	X—Orifice Nipple
F—Stop Valve	L—By Pass	S—Stop Valve	

sponding to approximately 30 pounds and continues to operate against the discharge pressure until a reduced water demand increases the pressure to a predetermined point, when the pump is automatically unloaded.

The unloading period of a reciprocating pump corresponds to the shut off period of a centrifugal pump with this difference: The reciprocating pump operates on the suction pressure when unloaded, with not more than 15% power consumption, whereas the centrifugal pump at shut off operates at a slightly greater pressure than 1000 pounds and consuming approximately 40% of the normal power.

ACCUMULATOR

The hydro-pneumatic accumulator, item "B", having a total volume of 2500 gallons and previously described, is equipped with a water level gage glass, air relief valve and pressure regulators. The accumulator should be installed fairly close to the pumps in the relative position as shown. An automatic valve (I) is installed in the line as shown. This valve is controlled by one of the pressure regulators (H) and its function is to close automatically in case of leakage when the pumps are shut down or if there is a breakage in the water line, preventing the loss of the compressed air in the accumulator. This valve is a cone type, air operated by means of a solenoid air pilot valve. The pressure at which this valve closes corresponds to a low water level in the accumulator.

The accumulator should be specified, being fabricated in accordance with the ASME code for Class 1 unfired vessels.

AIR COMPRESSOR

The air compressor selected for this installation and indicated by item (C) is a Worthington 4″/2″ x 7″ two stage, taking its air supply from a 75 pound service line. This compressor will charge the accumulator from 75 pounds to 1000 pounds in approximately three hours. This time for charging occurs only initially when starting up the system. Further use of the compressor is required only to replenish the compressed air lost by absorption and leakage. The compressor is started and stopped manually since its use is required only occasionally for a few hours service.

Fittings for the compressor should include the items shown.

OPERATING VALVES

The valves for controlling the water supply to the nozzles are shown at (E). It is important to select this valve for a minimum pressure drop. A valve with a restricted area results in not only a constant friction loss but also a high maintenance cost.

These valves are usually controlled from the operating pulpit. In some cases they are controlled automatically by means of flag switches manipulated by the slab. In either case, they are usually electrically controlled. These valves may be air operated with solenoid air pilot valves or direct electric thrustor controlled.

A stop valve, item F, should be installed ahead of each operating valve to facilitate repairs to the main valve without causing a shut down.

AUTOMATIC STRAINER

If filtered water is not supplied, then an automatic strainer (J) should be installed. The arrangement of stop valves and bypass shown is to allow repairing the strainer if a shut down of the system is to be avoided.

DISCUSSION

PRESENTED BY

H. B. MANN, Dravo-Doyle Company, Pittsburgh, Penna.

J. E. HOLVECK, Sales Engineer, Worthington Pump & Machinery Corp., Pittsburgh, Penna.

M. STONE, United Engineering & Foundry Co., Pittsburgh, Penna.

J. H. VOHR, Superintendent Hot and Cold Strip Mills, Granite City Steel Company, Granite City, Illinois.

HOWARD LINN, Superintendent 43'' Hot Strip Mill, Carnegie-Illinois Steel Corp., McDonald, Ohio.

C. L. McGRANAHAN, Assistant General Superintendent, Jones & Laughlin Steel Corporation, Pittsburgh, Penna.

H. B. Mann: Everyone in the pump business should give Mr. Holveck a lot of credit for the wonderful job he has done in developing the spray nozzle and its application to descaling work, for securing data on performance, and for following the matter through as he has done.

I have been especially impressed with the advantage mentioned by him of the use of caps over spray nozzles now in service. In analyzing some of these descaling applications to find the capacity of pumps required, this is a very important point. An example was a case I recently figured where the average pumping requirement was 1525 gallons per minute. This was based upon 46″ wide strips, on a 90″ mill. If caps were used over the nozzles when spraying this narrower strip, the requirements were reduced to the extent of 400 gallons per minute. With a plant consisting of one unit in operation and one spare unit, this represented a reduction in cost of pumps and motors of something like $10,000., to say nothing of the reduced operating cost.

In arriving at the capacity of the pump necessary, there are a lot of losses which no doubt Mr. Holveck would have pointed out if he had had the time. One he mentioned was the extra time of spraying due to the impossibility of timing the sprays exactly. He added two seconds to each pass. The operating time on the cycle he mentioned was 73 seconds, so that adding two seconds to each of 5 passes, or a total of 10 seconds, it increased the spraying by 14%. In other words, there is one item where the actual water requirement, compared with the theoretical, based upon the time the steel is in the rolls, is 14% greater.

Another factor contributing to increased pumping requirement is in bypassing the sprays. The practice is to have a hand-controlled bypass around the main control valve to the spray header. This bypass is set to keep the header full of water when not spraying, as a protection against water hammer. In addition, this passage of water helps to maintain circulation through a centrifugal pump to prevent overheating when actual spraying is not being done. When a header is operating, the water going through the bypass makes up part of the spray, and does not represent an increased load on the pump, but the headers which are not spraying are wasting water through the bypass, and this should be calculated. It follows that on a severe cycle the loss through idle nozzles is not as great as it is on an easier cycle, where less spraying is done. However, there is always a loss, which must be added to the required pump capacity.

To give you an idea of this, one case figured out a spraying load of 1150 gallons per minute, and the loss through the bypasses was 105 gallons per minute. On an easier cycle for the same mill, where the spraying load was 670 gallons per minute, the loss through the bypasses was only 114 gallons per minute.

A third point which should be taken into account in figuring pump capacity, is the actual pressure on the nozzles. If a system is designed for a minimum nozzle pressure of 1000 pounds, a normal operating pump pressure of about 1100 pounds would take care of friction losses, and insure the proper nozzle pressure at all times. It is obvious that on lighter loads the friction will be less, and also that the pump, at less than full capacity, will generate a higher pressure, so that the actual pressure on the nozzles, except at the extreme maximum load on the system, will be considerably above the design pressure of 1000 pounds. This of course is inherently true where an accumulator is used, as either in filling the accumulator, or during its discharge, the pressure will be above the minimum oper-

ating pressure. Although the discharge through the nozzles will only vary as the square root of the pressure, in actual cases, the extra discharge will amount to from 5 to 10 per cent of the theoretical discharge at the minimum operating pressure.

When these various extra requirements are added together, it makes quite a difference in the size of the pump, and while it might figure out in one case 25 per cent over the actual amount of water required to be sprayed on the steel, it will be seen from the nature of these losses, and the factors governing them, that it would be quite dangerous to set up any overall percentage to be added, unless the mill and its performance is to be a duplicate of the one from which the percentage was derived.

A very important point to be taken into account in the selection of a pump is the probable leakage or loss of capacity in the pump after a year or two years of service. This is a matter of pump design, and in some designs, taking into account the quantity of water to be handled, it is quite possible that the output of the pump at the end of two years, may be 10 per cent less than the output of a pump of different design.

Mr. Holveck mentioned a design of pump with which he has had experience, where severe shocks have caused serious trouble. While I have had considerable experience with both spray systems and hydraulic systems operating manipulators, where the shock is more severe, I have not encountered this trouble.

In connection with discussing the bypassing of nozzles, the arrangement worked out by Mr. Fred C. Norton at the Youngstown Sheet and Tube Company is very interesting. He has arranged a low pressure water supply to each spray header. This supply is connected through a check valve into the main supply line between the operating valve and the header. When the high pressure is on the header, the check valve closes. When the high pressure is not on the header, the low pressure water keeps the header full and saves a considerable waste of high pressure water. The pumps are protected from overheating by an ingenious arrangement for automatically opening a bypass when the water requirement is too low to carry off the heat generated in the pumps.

There is one thing I wish Mr. Holveck would tell us about some time, and that is the relation of speed of rolling to the amount of water and amount of force you apply to the sheet. I can't conceive of that not being a factor. If the steel is moving 500 feet a minute, I would certainly expect to get more results than if the steel were moving at 1000 feet per minute with the same gallons and same pressure. The sheet would be under spray twice as long. I don't know whether anything has been done in developing that, but I would think it would be a factor. In a mill extremely fast you might have to spray more than at points where the steel moved slower. If that could be developed, that might also allow us to better fit the pumps to the degree of descaling required.

J. E. Holveck: The time allowance for the sprays above the actual time of the slab in passing between the spray headers is a factor in estimating the pump capacity. In the maximum demand cycle mentioned by Mr. Mann, the loss is 14%. The loss for the cross rolling time cycle is 32%. For this reason it is important to select a valve which can be closely regulated and one that will maintain its fixed delay in opening and closing.

The loss through the bypass around the spray valves should be definitely fixed by means of an orifice through a hardened steel nipple. Taking into consideration the fact that the bypassed water is a loss only with the spray valves closed, then this loss for the maximum demand of Case 1 is only 70 G.P.M. or 5% of the average pump demand.

I believe the bypass arrangement more satisfactory than the use of low pressure water. The check valves in the latter arrangement are subject to severe duty since the valve is slammed on the seat by means of the velocity created by the difference in head of say 1000 pounds to 50 pounds. This occurs each time the spray valve opens and tends to cause severe wear in the valve and seat. It is possible that unless these valves are frequently repaired that the loss through leakage may be even greater than the bypass arrangement.

The third point mentioned by Mr. Mann is correct. The maximum average water demand must be based on the pressure at this demand. It is the writer's opinion that with the proper selection and arrangement of nozzles thorough descaling can be effected between 900 and 1000 pounds pressure.

The matter of speed of the slab or sheet in passing the sprays may have an important bearing on descaling. With a given flow of the jet, the jet is more effective at a low slab speed than at a higher speed. I cannot give any definite information on this question, but it is possible that some of the operating men present can give us some data regarding the point raised. I would say generally that with the nature of the scale the same in all stands, the gallons per inch required should increase as the speed of the slab increases or vice versa, to obtain the same descaling effect. However, the other factors of temperature, time, and nature of the scale may tend to equalize the value of the gallons per inch demand throughout the mill.

M. Stone: I would like to ask Mr. Holveck a question. In general you can always expect descaling matters to be given a very impartial and exhaustive treatise by Mr. Holveck. Certainly he has done so in this paper.

Leaving aside the controversial question of the reciprocal pump versus the centrifugal, the question of what is the best nozzle for spraying is one worth studying, and he devoted a lot of time to it in his paper. Whether the descaling sprays cools the strip and cracks off the scale or knocks it off, the criterion of the nozzle is the impinging force on the strip, because that is a measure of either the heat extraction or the force. I wonder if Mr. Holveck could give us some facts on the ratio of the actual force to the theoretical on the nozzle, such as he described. That is, the force theoretically is two times the pressure times the area, and the actual force is a composite measure of the nozzle efficiency plus the diffusion of the nozzle.

J. E. Holveck: The ratio between the actual impinging force and the theoretical is about .95 with the Worthington nozzle.

M. Stone: That is a function of the distance away from the nozzle.

J. E. Holveck: The impinging force varies slightly up to a distance of 12″; beyond this the efficiency drops off materially.

J. H. Vohr: As an engineer Mr. Holveck emphasizes the economies possible by the use of reciprocating pumps, but as an operator I have a preference for the centrifugal type, as it has been my experience that the latter is more likely to guarantee continuous operations under any and all conditions and especially so when rolling at a high rate. I feel that hydraulic sprays when applied to hot strip are of such extreme importance that the economy of operation is really secondary. It does not take many strips of the length as rolled at present, to overbalance the greater cost of operating the centrifugal pump, if there is pump failure or the nozzles are restricted.

I fully realize, however, that there are many who will say that the reciprocating pump is an equal of the centrifugal type in all respects, my reply can only be based on my experience. I cannot deny however, that where the rate of rolling is slow and therefore considerable interval between the strips, and consequently between hydraulic spray operation, the arguments are all in favor of the reciprocating type.

It has been interesting to us to learn that 750 pounds pressure at the nozzles represents the absolute minimum pressure possible to use and still obtain the "best possible surface." Accordingly it has always been our practice to maintain not less than 1000 pounds pressure at the pumps so that we may be assured of satisfactory results. I differ, however, with Mr. Holveck when he states that the jet should be 15° off the vertical Is a much prefer an angle of 25°.

J. E. Holveck: The question of the type of pump remains with the purchaser who through their engineers and operators should be in a position to determine all phases of operation and maintenance and make the proper selection.

The angle of the jet at 15° is arbitrarily selected to give practically full flow in one direction. An angle of 25° may also be used, however, this latter angle requires about 5% more water to obtain the same impinging force as 15°.

Howard Linn: The importance of cutting off sprays is fully realized, both from an economical standpoint by the conservation of water, and in the cooling effect on the edges of the strip. The development of a light weight cap for cutting off sprays would present a much more desirable means of attaining this end than the use of slides.

The overlapping of sprays, as brought out in Mr. Holveck's paper, is a very important factor for various reasons: This condition often brings about the appearance of black streaks through the strip; it causes the strip to camber or to run off bearing, and it very often produces a variation in gauge. Exaggeration of a red oxide condition on the edges of the strip is another especially prominent objection to such an overlapping of sprays on the edges of the strip.

While the descaling of steel is the primary object of the paper, Mr. Holveck mentions the cooling effect which would result from an increased value of "G".

In some cases, it is highly desirable to rapidly cool the steel as it emerges from the finishing stands. High pressure water directly after the last stand has been used in many cases for this purpose, but on the heavier gauges (.100 ga. and heavier), its effect is negligible, and in fact undesirable from a metallurgical standpoint if the steel is merely quenched on the surface and not thoroughly cooled.

C. L. McGranahan: I think Mr. Holveck should be congratulated upon the excellence of this paper and on the thoroughness and effort he has put into compiling a manuscript of this type.

Program

AMERICAN IRON AND STEEL INSTITUTE

MAY 28, 1936 — **WALDORF-ASTORIA, NEW YORK CITY**

MORNING SESSION—10 A.M.

ADDRESS OF THE PRESIDENT—
E. G. GRACE, *President*
Bethlehem Steel Corporation

COMPETITION FROM IMPORTS OF FOREIGN STEEL PRODUCTS—
W. A. IRVIN, *President*
Unites States Steel Corporation

PROBLEMS CONFRONTING THE INDUSTRY—
T. M. GIRDLER, *Chairman*
Republic Steel Corporation

A SOUND COMMERCIAL POLICY FOR STEEL MAKERS—
E. T. WEIR, *Chairman*
National Steel Corporation

LABOR RELATIONS IN THE STEEL INDUSTRY—
CHARLES R. HOOK, *President*
The American Rolling Mill Company

REPORT ON INSTITUTE ACTIVITIES—
W. S. TOWER, *Executive Secretary*
American Iron and Steel Institute

LUNCHEON—12:45 P.M.

AFTERNOON SESSION—2:15 P.M.

ELECTRIC FURNACES AND THEIR PART IN METALLURGICAL PROGRESS—
FRANK R. PALMER, *Assistant to the President*
The Carpenter Steel Company

RECENT ADVANCES IN OPEN HEARTH FURNACE DESIGN AND OPERATION—
L. F. REINARTZ, *Works Manager*
Middletown Division
The American Rolling Mill Company

THE NEW TECHNICAL AND ECONOMIC IMPORTANCE OF IRON AND STEEL SCRAP—
CLYDE E. WILLIAMS, *Director*
Battelle Memorial Institute

A REVIEW OF METALLURGICAL PROGRESS—
DR. ALBERT SAUVEUR,
Gordon McKay Professor of Metallurgy
Harvard University

EVENING SESSION—7:30 P.M.

BANQUET..... *Grand Ball Room*

MILL MOTORS AND MOTOR ROOMS

THEIR VENTILATION IN STEEL MILLS

By H. H. ANGEL, Electrical Dept. Bethlehem Steel Co., Sparrows Point, Md. and C. B. HUSTON, Industrial Engineering Dept., General Electric Co., Schenectady, New York.

Presented before the Philadelphia Section of A. I. & S. E. E., December 7, 1935

▲ THIS is a subject of great interest to the builder of motors and generators as well as to the user of electrical equipment throughout the steel industry. It becomes of increasing importance because of the rapid growth of motor capacities and of the concentration of large sources of power within the motor rooms such as we find in modern hot and cold strip mills. It is vital to the successful operation of the electrical equipment, as well as to the comfort of the station attendant.

Whereas a few years ago, the power concentrated in one station may have been represented by 15,000 HP in connected motor capacity and 10,000 kw in motor-generators, we now find our motor rooms of a new wide hot strip mill with approximately 40,000 HP in motors and 20,000 kw or more in motor generators. This means instead of handling 1500 to 2000 kw in losses, we must now provide in the ventilating systems capacities to handle upward of 4000 kw in actual losses within one motor room.

It is the intent of the writers to discuss in this article some of the essential problems in connection with the design of ventilating systems and cite a few examples of recent installations.

CALCULATION OF LOSSES

The first problem is to determine the amount of loss to be handled. If there are only a few machines, and especially if they are subjected to practically a constant load, the losses can readily be determined by calculating the full load losses and applying a load factor suitable to the particular application. However, when a large number of machines are involved, and especially when they are working intermittently, then the particular duty cycle must be taken into consideration in determining these losses.

In Table I, we have an example of the calculations of the total losses of all of the machines in the motor room of a hot strip mill. This case is a hypothetical one, but serves to illustrate the problems at hand and can be suitably applied to any type of mill and of any size. From the duty cycle which we recognize to be the heaviest schedule, we figure out for each motor and motor-generator, the KW-seconds loss for the duration of the cycle. In this case, the cycle lasts for 30 seconds, meaning that every 30 seconds, it is repeated.

We first determine for each motor the losses, while load is being carried, from the efficiency at the specified

H. H. ANGEL

C. B. HUSTON

load, and knowing how many seconds metal is in the stand driven by the particular motor, we thus obtain a figure of kw-seconds for the loaded period. Secondly, we figure the losses in kw-seconds for the unloaded period knowing the time that the mill runs without metal in these particular rolls and also knowing from previous tests or experience, how much friction load there is on the motor.

These two values are now added together to get the total kw-seconds loss for one motor or motor-generator, as the case may be. We then take the grand total in kw-seconds and divide by the time of the cycle in seconds and arrive at a figure of kw loss for all of the machines in the station.

QUANTITY OF AIR

Air is our usual medium for cooling the machines, therefore, after having determined the kw loss, we must next find how much air is needed to absorb these losses. This quantity of air is usually expressed in cubic feer per minute.

1 kw-hour = 3417 Btu or 57 Btu per minute

The heat absorption of air is then determined from the formula

$$\frac{57}{0.2375 \times 0.073} = 3290$$ cu. ft. of air per minute per 1 kw loss for 1°F rise in temperature.

Where 0.2375 is the specific heat of air, and 0.073 is the weight of a cubic foot of air at an average temperature of 85°F. suitable for ventilation.

The amount of air used should be sufficient in all cases to carry away the losses, and hold the maximum temperature rise of each machine within its rating. For a machine with a standard temperature rating, namely, 40 deg. C. rise, it has been determined from previous tests that about 100 cu. ft. of air per minute will be required for each kw loss. A greater quantity of air may be recommended in some cases, especially where a large number of motors and generators are to be ventilated in one room, in order to assure plenty of

TABLE I

Calculation of KW. Loss in Motor Room for Maximum Schedule

Based on cycle repeated each 30 seconds

Types and Ratings of Motors	Pass	HP Load	Time in Seconds Loaded	Time in Seconds No Load	% Eff. of Motor at Load	Loss in Kw. at Load	Loss in Kw. No Load	Kw-sec. Loss		
								Loaded	No Load	Total
2000 HP (Syn.)	1	3410	2.99	27.01	95	140	60	420	1620	2040
2000 HP (Syn.)	2	3020	4.60	25.40	95	120	60	550	1520	2070
2250 HP (Syn.)	3	3850	4.83	25.20	95.5	140	55	670	1390	2060
2250 HP (Syn.)	4	3630	8.31	21.70	95.5	130	55	1080	1200	2280
1750 HP (D-C)	5	2000	16.2	13.8	93	110	50	1780	690	2470
2250 HP (D-C)	6	2760	16.2	13.8	94	130	60	2110	830	2940
2250 HP (D-C)	7	3060	16.2	13.8	94	145	60	2350	830	3180
2250 HP (D-C)	8	2740	16.2	13.8	94	130	60	2110	830	2940
1750 HP (D-C)	9	2290	16.2	13.8	93	130	50	2110	690	2800
1750 HP (D-C)	10	1990	16.2	13.8	93.5	105	50	1700	690	2390
(2) 5000 KW	Motor Gen.	9590	30	0	90	800	..	24000	0	24000
								Grand Total		49170

Average KW Loss of all machines is $\frac{49170 \text{ KW-sec. loss}}{30 \text{ sec. cycle}} = 1639$ KW.

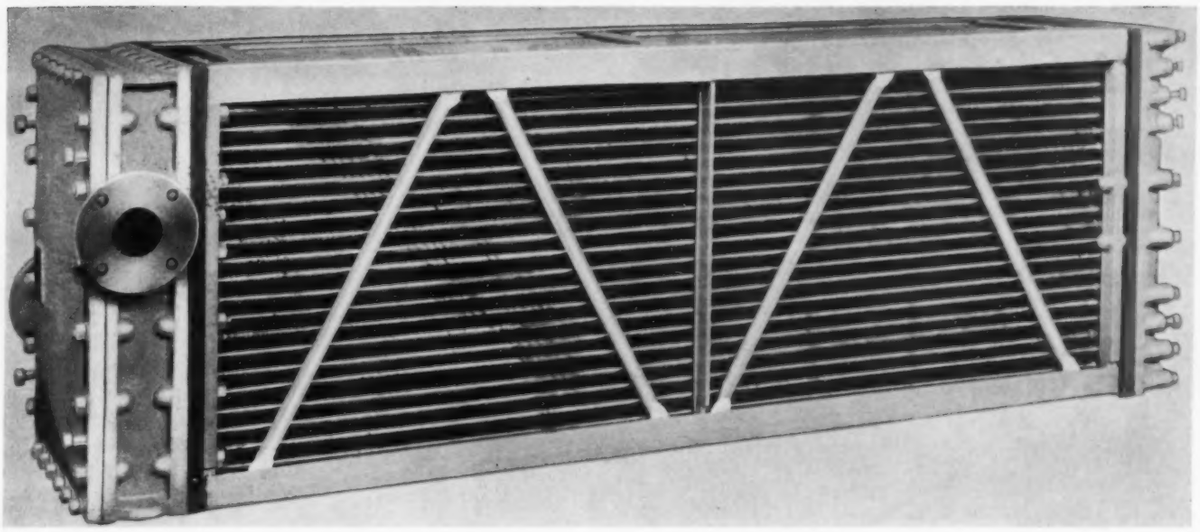


Fig. 1—Surface air cooler of the type used for recirculating system.

air for each machine. The greater the quantity used, the more rapidly will the losses be carried away, and the lower will be the operating temperature of the machine, as well as the temperature of the outgoing air. In Table II below, there is given, for convenience, the temperature rise of the ventilating air for various quantities in cubic feet per minute for each kw loss.

TABLE II—QUANTITY OF AIR

Cubic Feet per Min. per KW Loss	Rise in Degree F. Ventilating Air
100	32.9
110	29.9
120	27.4
130	25.3

The value frequently used for figuring the total quantity of air for a large station is 120 cu. ft. per minute for each kw loss.

DISTRIBUTION OF AIR

If only one machine is to be ventilated, it is of course an easy matter to direct the whole of the ventilating air through this one machine. Where there are several motors and generators in one station, the ventilating air must be proportioned between them in accordance with the requirements of each machine. Some provision must, therefore, be made in the design of the ventilating housings, the air ducts, or the construction of the foundations so that the amount of air may be adjusted, otherwise, some of the machines may receive more and others less than their share. After these dampers, or whatever means of control have been provided, are adjusted, they should then be securely bolted in place because after that, it should not be necessary to change them.

Even though great care be taken to properly distribute the air between the several machines, it always is difficult to measure the quantity which each motor or generator gets, and for this reason alone, it is advisable to be liberal in the quantity of air used, especially when a large number of machines are to be ventilated. This accounts, therefore, why we recommend the figure of 120 cu. ft. of air per minute per kilowatt loss, whereas 100 cu. ft. may be sufficient for each machine insofar as meeting its 40 deg. C. temperature rise.

RECIRCULATING SYSTEM

A ventilating system should serve two purposes: One to keep the apparatus cool, and two, to keep it clean. A recirculating system if properly installed, will answer both of these requirements, keeping the machines clean as well as cool.

SURFACE AIR COOLERS

A recirculating system requires the use of some device by which the heat losses picked up by the air, when passing through the machines, may be transferred to some other medium and carried away. This apparatus is known as a surface cooler through which water is circulated on the inside of tubes and the air passes over the surface on the outside of the tubes.

Fig. 1 illustrates the type of cooler used for this purpose. The tubes which are copper are assembled between two cast heads. It will be noted that there are fins on the outside of the tubes in order to increase the contact surface with the air and therefore increase the rate of heat transfer from air to water. In Fig. 2A, we have a cross-sectional view of a surface air cooler showing the circulation of the air and water. It will be noted here that the circulation of the air is counter to that of the water, that is, the air enters the same side of the cooler from which the water is discharged. Also, it will be noted that the water passes back and forth several times from one head to the other before it

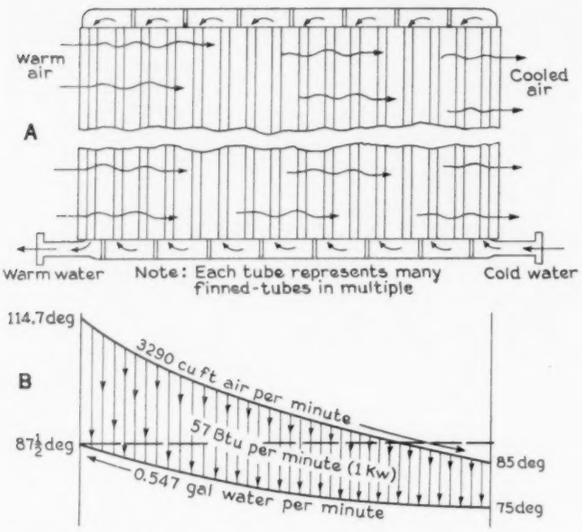


Fig. 2—(a) Sketch showing the circulation of air and water through a surface air cooler. The flow of the air is counter to the flow of water.

(b) Graphic chart of temperature gradient between ventilating air and cooling water as the air passes from one side to the other of the surface air cooler. It will be noted that the air may be reduced to a temperature at its discharge which is lower than the temperature of the water before the latter leaves the cooler.

leaves. Each tube in the sketch represents a row all in parallel; also two or more rows may be grouped together thus reducing the number of circuits back and forth between the heads. This is a matter of variation in design of the apparatus to meet different requirements.

QUANTITY OF WATER

The question naturally arises at this stage as to how much water is required and at what temperature the water need be. The design of the cooler is in fact centered around these factors; one, the temperature of the incoming cooling water, and two, the temperature desired for the outgoing air, as well as three, the total amount of heat units to be absorbed. A temperature gradient of 10 deg. F. is about as low as can be obtained economically. This means if we have 75 deg. F. water, we can expect to cool the air down to 85 deg. F. Furthermore, it will be noted by referring to the graphic chart, Fig. 2B, that with a flow of air counter to the flow of water, we can have the temperature of the outgoing air less, by several degrees, than the temperature of the outgoing water. A well balanced design of cooler will, for a temperature gradient of 10 deg. F, water to air, cause a rise in the temperature of the water about 12½°F.

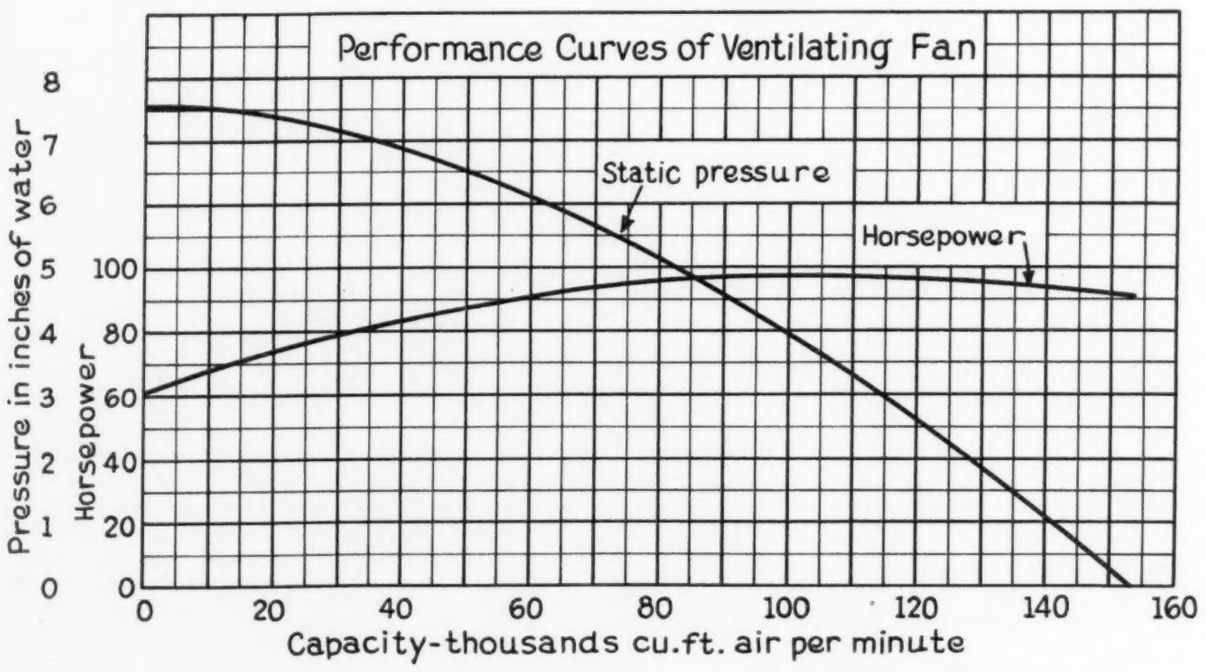
The quantity of water required may be calculated from the same basic formula as that used for the quantity of air. We have, therefore,

$$\frac{57}{1.0 \times 12.5 \times 8.33} = 0.547 \text{ gals. of water per minute per kw loss}$$

where, 57 is the Btu. per min. for each kw loss
1.0 is the specific heat of water
12.5 is the temperature rise of the water, and
8.33 is the pounds of water in 1 gallon.

It will be seen, therefore, from the above, that we can start out with 75 deg. F. water and cool the air down to 85 deg. F., and when so doing, consume 0.547

Fig. 3—Performance curves of ventilating fans.



gallons of water per minute for each 1 kw loss. If less water is used for a given design of cooler, the temperature of the outgoing air will be greater, as well as there will be a greater rise of the temperature of the water. The station and the machine will under such conditions run hotter. On the other hand, if the equipment is not operating up to full schedule, or if the water temperature is quite low, as it may be through the colder months, then the quantity of water may accordingly be reduced. As a matter of fact, the temperature of the station may be controlled at the convenience of the operators by regulating the amount of cooling water used.

FAN LOAD LOSSES

Fans are required to circulate the air, forcing it through the various ducts, through the machines, as well as through the air coolers. This represents work which goes into heat and may account for a rise of 2 to 3 deg. F. in temperature of the air. The temperature rise of the air as it passes through the fan may be only a fraction of a degree, because it is only the internal losses of the fan which are here to be accounted for. The rest of the temperature rise due to circulation occurs at the various points where the air meets resistance to its flow, whether it is in the machines, the air ducts, or even in the coolers. The total fan load in terms of kw input to the fan motors may therefore be included when calculating the total losses in the station.

LOCATION OF FANS

It is preferable to locate the fans at the cold air side of the coolers. They will then be required to handle the air at its lowest temperature where the density is the greatest. As a rule, it will be found convenient to place the coolers on the intake side of the fan, and other things being equal, this arrangement should be chosen. There may be times, however, when this rule cannot be followed, and if so, the temperature of the hot air should be taken into account when picking the size of the fans, and furthermore, in such cases, arrangements should be made if possible to place the driving motor outside of the hot air chamber.

MAKE-UP AIR

It is the general practice on these recirculating systems to provide for continuously bringing into the station a small quantity of clean air which keeps the station under pressure slightly above that at atmosphere. In this way, dirt from the outside may be prevented from filtering into the station because at all cracks or openings, the air will instead be leaking outward. Also, a supply of make-up air may be necessary to replace a steady drain that may be caused to take care of ventilating certain auxiliaries which are outside of the motor room and to which air may be piped direct from the station. The capacity of the make-up equipment will therefore be affected by whatever supplementary drain there may be for auxiliary purposes, but exclusive of these, it is usually chosen at 10% of the total volume of air recirculated in terms of cubic feet per minute.

The point at which the make-up air may be brought into the system is immaterial insofar as producing a pressure above atmosphere is concerned. It usually is found convenient and in many respects is preferable to deliver this air direct to the motor room. If the make-up air is delivered to the high pressure chamber following the main circulating fans, then the make-up air fan will be required to operate at a higher static pressure by an amount equal to the pressure drop from this high pressure chamber to the motor room, otherwise air would be forced outward through the make-up equipment in the case of the opening of doors or entrances to the station.

Likewise, if the make-up air is to be delivered to the intake side of the circulating fans, care should be taken

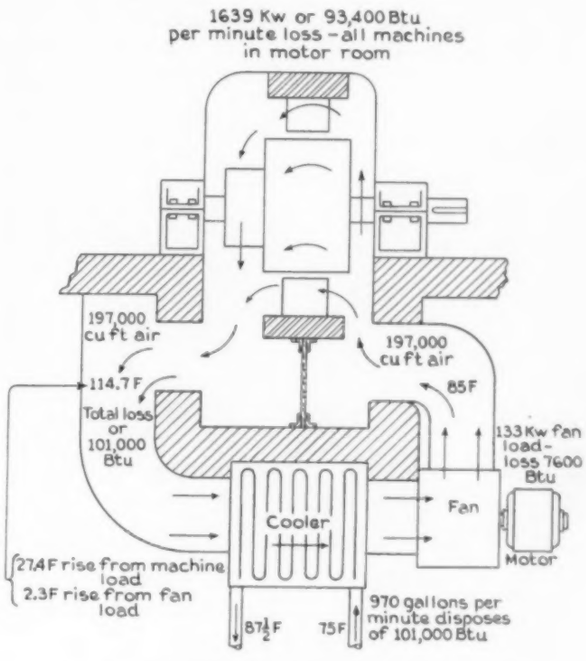


Fig. 4—Heat cycle for station with recirculating ventilating systems.

that the pressure drop through the air intake equipment is not less than it may be through the coolers and machines, otherwise, an excessive amount of air will be drawn in through the aid of the main fans each time that the station doors or other openings may be left open.

It is preferable, therefore, that the make-up air be delivered direct to the motor room. The pressure required of the make-up fan need not be high, namely, $\frac{3}{8}$" to $\frac{3}{4}$" water gauge.

FAN CHARACTERISTICS

It is desirable that the fans have non-overloading characteristics. This applies equally well to the main recirculating fans, as well as the intake fans. In the case of the air intake fans, as just noted above, we may not have control at times of the pressure at which these fans may be required to work. If someone should

leave a door of the station open, then the make-up fan would tend to draw in a much greater quantity of air because of the reduction in the pressure head against which the fan works. Therefore, this fan, in particular should have a decidedly drooping characteristic to its load curves in volume of air versus pressure, as well as the horsepower input to the fan should be as nearly a constant value for all various volumes as is possible to obtain.

The same comments also apply to the main recirculating fans. For any ventilating system, it is good practice to install two or more fans so as to have some diversity in operation, using only a part of the equipment when the mill is operating under light schedule or during the colder months of the year. In any case, the air duct and the openings through the machines will all be adjusted for the maximum volume of air, which represents a given pressure drop. Then, since it is not contemplated that these openings be changed from time to time, and we operate with fewer fans in service, handling of course less total volume, the pressure drop through these various openings will accordingly be reduced. On this account, those fans which are in service will deliver more than their rated capacity, and when so doing, should not overload the driving motors. A drooping volume characteristic, and a flat horsepower input curve is desirable.

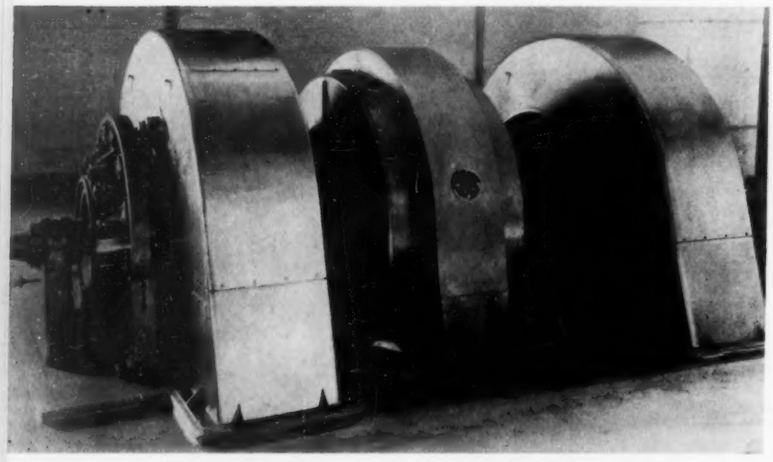


Fig. 5—Motor-Generator equipped with volute housings on the generators and enclosed stator frame for the synchronous motor, both of which provide for downward discharge of the warm air from the machines.

Fig. 3 illustrates the performance curves which are desirable in these ventilating fans. It usually will be found that the fans manufactured can conveniently meet these requirements.

MAKE-UP FILTER

Special precaution should be taken in choosing the filter for the make-up air to see that it has ample capacity to handle the maximum volume that the make-up fan may deliver against practically a zero pressure. This is important in order that the filter will not be overloaded under any circumstances and thus operate at much reduced efficiency. If the filter be of the oil coated type, then it is of special importance that the capacity be ample for the conditions of maximum volume that the fan will be called upon to produce, in order to ensure that no oil will be carried through into the system. Recommendations may vary, of course, depending upon the local conditions, but it is good practice to use for steel mill service air filter with 25% greater area than standard listed ratings.

HEAT CYCLE

In Fig. 4, we have a sketch which illustrates the complete heat cycle for the hypothetical case for which the losses in the station have earlier been determined. We find that there is generated within the machines a loss of 1639 kw per minute. On the basis of 120 cu. ft. of air per minute per kw loss, we will require a total of 197,000 cu. ft. of air per minute.

From the performance curves of the blowers, we find that to circulate this much air against the pressure which we are likely to have, will require 133 kw input to the driving motors. This loss will therefore be added to the loss in the main machines, making a total of 1772 kw as the total loss per minute for the station. In heat unit, this corresponds to 101,000 Btu. per minute.

The ventilating air which starts out from the surface air cooler at 85 deg. F. will be raised 27.4 deg. F. in absorbing the losses of the main machines and increased 2.3 degs. F. in absorbing the losses represented by the work necessary to circulate the air. This gives us a total rise of ventilating air 29.7 degs. or a temperature for the air entering the cooler of 114.7 deg. F.

With cooling water at 75 deg. F., the ventilating air may be reduced from the incoming temperature of 114.7 deg. F. to 85 deg. F. and in so doing require 970 gals. of water per minute.

ECONOMY IN BUILDING CONSTRUCTION

With a recirculating system no roof ventilators need be provided for the discharge of large volumes of warm air, such as are required in the design of a station with the usual type of ventilating system. Roof ventilators or other opening suitable to take care of the warm air of the station are expensive items in the cost of the building. This cost can therefore be spared and applied to the cost of the cooling apparatus. As a matter of fact, no openings except doors necessary for access to the station need be provided. Windows may, if desired, be omitted and artificial lighting used entirely. In any event, the doors and windows must be kept closed.

COST OF COOLING WATER

The water used for the surface air coolers is useful for cooling purposes on the rolls and bearings of the mill and therefore may serve a double purpose. The pressure drop through the coolers is low, namely 15 to 20 pounds. Therefore, the cost of the water chargeable to the operation of the recirculating cooling system is a very small item of expense.

DOWN DRAFT CIRCULATION

In recirculating systems earlier installed, the air has been forced up either through all machines in parallel or through some of the machines from basement to main room and then taken up by the remaining machines and discharged back into the basement. The former will be recognized as a parallel system, and the latter as a series system. In either case, the air passes through some or all of the machines before entering the room, and therefore accumulates heat which raises the ambient temperature of the station.

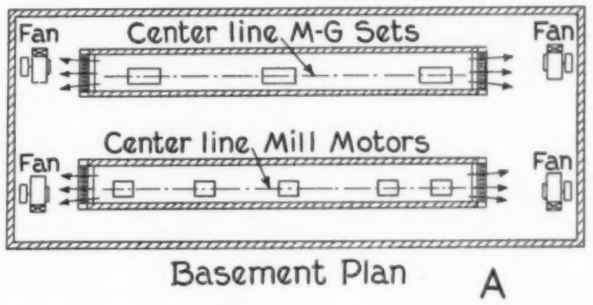
In the so-called "down draft circulating system" the warm air from all machines is discharged downward direct into the basement, and cooled before it is delivered back into the room. This system has the advantage, therefore, in producing a low ambient temperature for the main motor room, and not only greatly adds to the comfort for the station attendant, but also is beneficial to the successful operation of the various auxiliary equipments, such as exciters, rheostats, switching equipment, etc., to which ventilating air is not carried direct. In order to take the fullest advantage of a down draft discharge scheme, all machines should be so equipped with covers that the warm air may be collected and directed to the basement. Such arrangement is readily obtained in the design of alternating current machines but not so easily accomplished in direct current machines.

In synchronous and induction motors we have a box type construction of frame which may be made totally enclosed except for an opening at the bottom. The warm air may thus be collected and delivered to the basement below. It is, in fact, possible to attach a surface air cooler direct to the discharge opening of the machine, or at least connect same to this opening through ducts. On high speed motors of either synchronous or induction type, sufficient pressure can be obtained with fan blades on the rotor of the machine so that the motor will draw from the room and discharge through the coolers, all of the air required for ventilating it. On slow speed motors, it may be necessary to install a separately motor-driven fan by means of which the air may be assisted in its circulation. In either case, the cold air from the coolers underneath the motors may be permitted to rise up into the motor room through the openings around the foundation, or, if desirable, be returned through separate ducts.

In the case of direct current generators of synchronous motor-generators, which operate at high speed, volute housings may be furnished which are very effective for collecting and directing air into the basement. Figure 5 is a view of such a motor-generator. The ventilating air for each generator is drawn into the machine from the room along the shaft and commutator, collected in the volute housing and discharged into the basement. The synchronous motor likewise is designed to take air from the room and discharge it downward into the pit under the machine.

In the case of the direct current mill motors, it is not usually convenient to apply the volute housings for reasons: (1) lack of sufficient floor space at the side of the magnet frames for the housings, and (2) the motors operating through wide range of speeds would handle a big difference in the amount of air, depending upon the speed at which it may be running. Therefore, if enclosures are to be used some other type will be required.

Some installations have been made where no covers at all have been used on the DC motors. We are depending in such cases solely upon the suction of the fans in the basement to draw the warm air liberated from the machines before it mixes freely with the air in the immediate surrounding. Since the natural ventilation of the motor is radial from its armature, a great amount of the warm air will be discharged which cannot be collected and drawn direct into the basement.



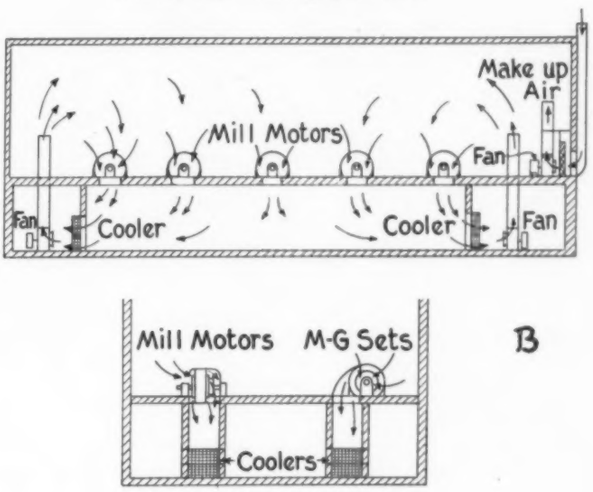


Fig. 6—(a) Basement plan, and (b) Elevation of a recirculating ventilating system with down draft discharge of the warm air from motors and motor-generators.

We may first propose enclosing the coupling end in the manner as that usually employed when air is forced from the basement through the motor into the room. However, there are difficulties encountered when trying to reverse the flow of air through the machines with the usual coupling end enclosure. The scheme may work on slow speed motors of large diameter, but may not work on high speed motors of small diameter, and therefore is not generally applicable. On the small machines, the diameter of the commutator and the opening through the commutator shell may be so small that a sufficient amount of air cannot be carried to the inside of the armature where it is needed for circulating through the ducts of the armature punchings. Therefore, the air entering the armature must be allowed to come in at the coupling end. These conditions can be

successfully met by putting enclosures over the commutator end of the motors. Although this arrangement has not been generally accepted by the trade, in practice the scheme is applicable to most any size of machine.

It becomes a matter of compromise, therefore, as to whether any covers at all are to be used on the direct current machines, either motors or generators. Covers of any sort especially those at the commutator end impair the acessibility of the machine. Therefore, the user must choose between either degree of accessibility of the machines for maintenance or increased room. Section B shows in either case how the air for the machines is drawn from the room directed through them and collected in the hot air chamber underneath without being allowed to escape into the room.

A recent installation of a recirculating ventilating system which in itself is unique is that for the five-stand 42" tin tandem mill of the Bethlehem Steel Co. at Sparrows Point, Md. The mill is driven by five 800 HP direct current motors, and one 150/225 HP reel motor. Power for the mill and also power for the various mill auxiliaries are furnished from a 3500 Kw synchronous motor generator.

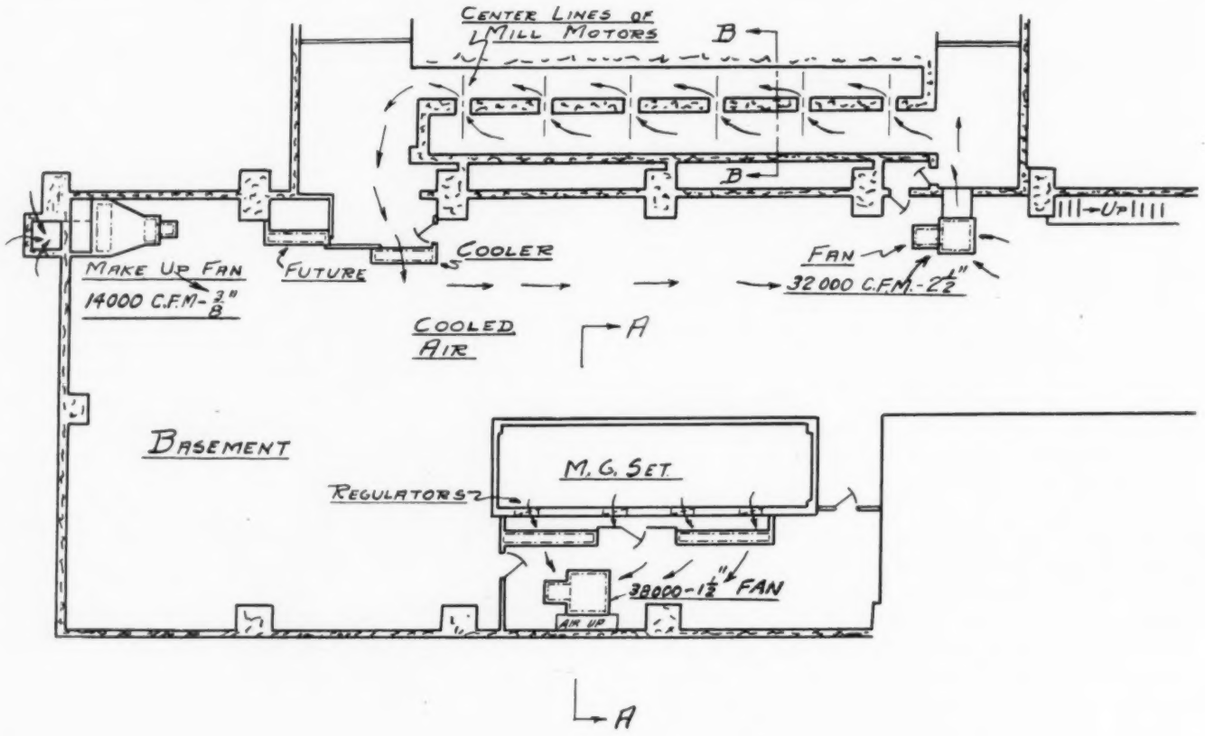


Fig. 7—Basement Plan of motors and motor-generators showing fans and surface air coolers for recirculating ventilating system used on a 42" 5-stand tandem cold strip mill.

efficiency of the ventilating system with lower ambient temperature in the station.

In Figure 6, section A and B we have an illustration of a ventilating system which may be considered solely from the view point of maximum efficiency in keeping the electrical equipment cool and clean, as well as to have the lowest possible ambient temperature in the station. In Section A, there is a basement plan showing that the foundations under the motors and the motor-generators constitute separate air ducts for collecting the hot air at either end of which are located surface air coolers through which the air must pass before entering the fans and be delivered back into the motor

On account of the motors being out in the mill, the ventilating system has been divided into two units, one for the synchronous motor-generator and main station, and the other for the motors driving the mill and reel. Fig. 7 shows the plan of the basement which includes the foundation for the mill motors, as well as the motor generator. Fig. 8 is a cross-sectional view of the motor generator with its cooler and fan for discharging the air back into the station. Fig. 9 is a cross-sectional view of the foundation for the motor which shows how air is carried to the machine through one duct and then collected and carried away from the machine through a separate duct.

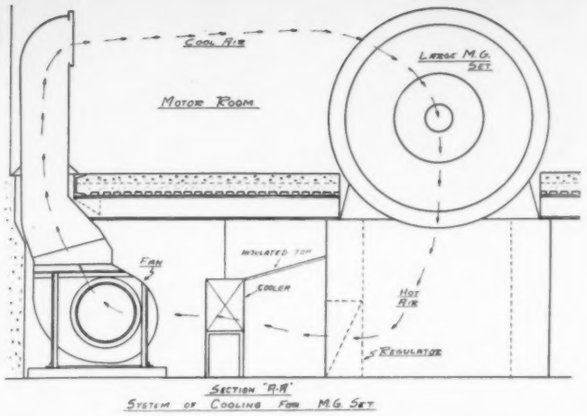


Fig. 8—Section through motor-generator showing the recirculation of the air from the machines through the cooler and back into the motor room, of a 42" 5-stand tandem cold strip mill.

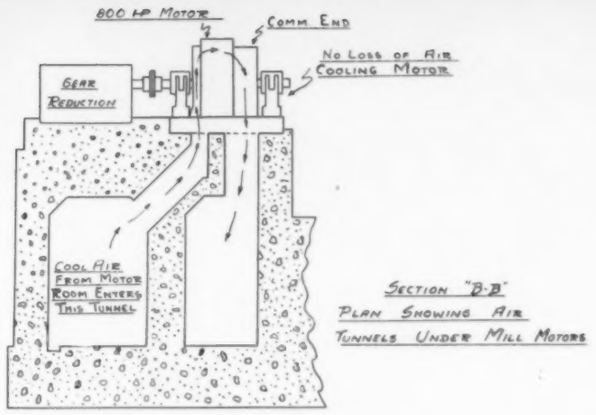

800 HP Motor
Comm End
No Loss of Air Cooling Motor
Gear Reduction
Cool Air From Motor Room Enters This Tunnel
Section "B-B"
Plan Showing Air Tunnels Under Mill Motors

Fig. 9—Section of foundation showing air ducts for conducting the air to and from the motors of a 42" 5-stand tandem cold strip mill.

In the case of the motor-generator, the ventilating air is simply gathered by the machines from the room. The air entering along the shaft is discharged into the compartment of the basement within the foundation of the machines. The air is then drawn through the coolers by the suction of the fan and discharged back into the room above.

In the case of the mill and reel motors, which are located out in the mill building, it is necessary to conduct the air to and from the machines. The fan is so located that it will discharge direct into a tunnel or duct leading to the motors. The air enters the motors at the coupling end and is collected at the commutator end from where it is discharged into the duct which carries it to the coolers. Each motor is equipped with enclosures at either end so that no air escapes into the mill. The fan in this case must provide the pressure for not only forcing the air through the machines but also to overcome pressure drop through the air ducts, as well as the surface air coolers.

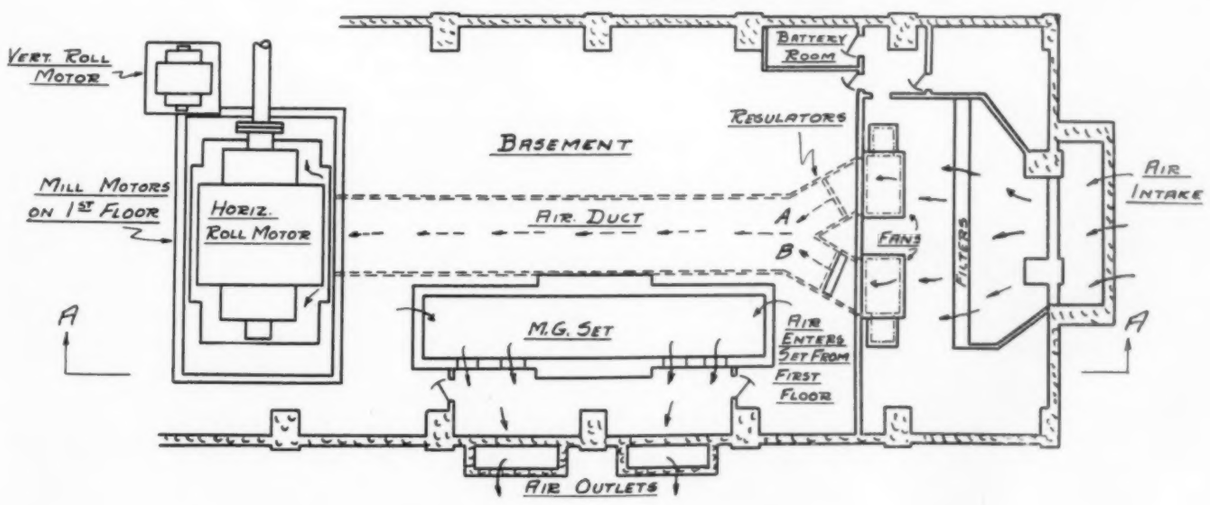
A make-up fan and filter is provided so that each system will be kept under pressure slightly above atmosphere, as well as to provide for a certain amount of drain from the system for taking care of ventilating various auxiliaries.

NON-RECIRCULATING SYSTEM

For those who do not have available a sufficient supply of cold water for use in a recirculating system, all of the ventilating air must be drawn from out of doors filtered, and then discharged after it has been passed through the machines. It is not expected under such conditions that the motor room can be kept as cool on hot days or that the station can be kept as clean as is obtainable with the recirculating system. Nevertheless, the advantages of a down draft circulation can be taken by bringing all air direct from the filters into the motor room before it is passed through any of the machines. In this way, the ambient temperature of the motor room may be kept at as low a value as possible consistent with the temperature out of doors. The same schemes and arrangements previously described under the recirculating system for collecting the warm air from the machines may be used, except in this case the warm air must be conducted to the outside of the station. With a little planning, the major portion of the basement may be used as a chamber into which to collect the hot air, and then provisions made for discharging this warm air to out of doors.

In the case of the synchronous motor generators, the volute housings may be found desirable because with them the fan action of the machines can be utilized to exhaust all of the air required for the ventilation of these particular machines. Likewise, in the case of

Fig. 10—Plan of basement showing foundations of machines, ventilating fans, and air filters of Motor room for a 40" Universal Slabbing Mill.



Plan of 40" Universal Slabbing Mill Motor Room

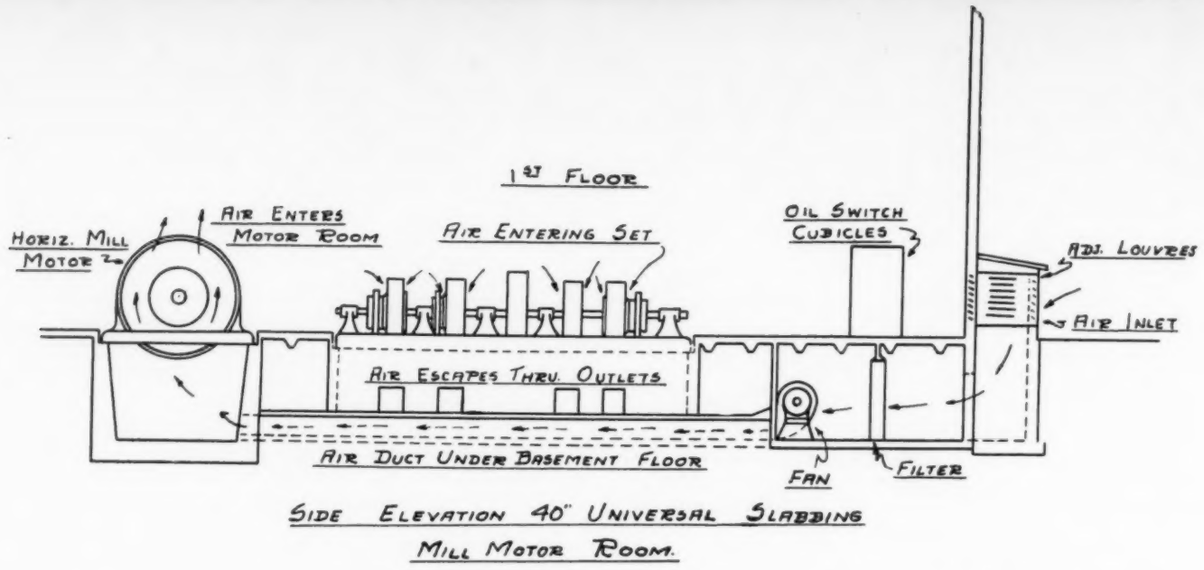


Fig. 11—Elevation showing the circulation of air brought in from out of doors filtered and forced up through the motors and through openings around the motor generator into the main motor room of a 40" Universal Slabbing Mill.

most of the alternating current motors, sufficient pressure will be set up by their rotors that the fan action thus afforded can be utilized for the discharge of the warm air. In the case of the direct current mill motors, it will be necessary to use separate fans to exhaust the warm air collected underneath them.

If any event, arrangements should be made so that intake louvres ahead of the filters can be partially closed and openings from the motor room to the intake side of the fans opened up so that in cold weather a portion of the air within the station can be recirculated. The control of these openings or dampers should be made sufficiently convenient to the operators that the amount of air recirculated can be changed while the equipment is operating. The temperature within the room can in this way be controlled for the convenience of the attendants, as well as for the best operation of the machines.

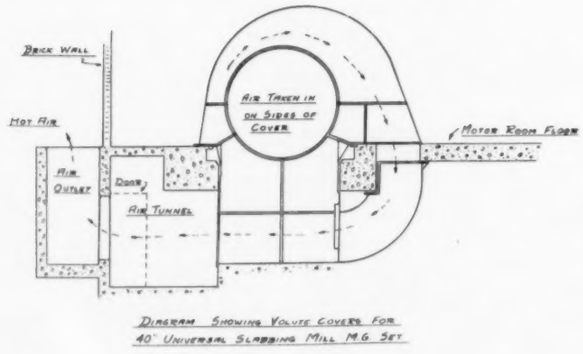
An installation which is an example embodying most of the features discussed above for a non-recirculating system, is that of the 40" Universal slabbing mill of the Bethlehem Steel Co., Sparrows Point, Md. This drive consists of a 7000 HP double-unit horizontal roll motor and 2500 HP vertical roll motor, with a flywheel motor-generator set consisting of three 3000 kw. generators and one 6000 hp. motor. Provisions are also made for two 1000 kw. 250 volt synchronous motor generators for general mill power purpose.

Fig. 10 is a plan of the foundation and basement for the motors and the motor-generators. It will be noted that the air is brought in from the out of doors filtered and then placed under pressure by two fans. In Fig. 11 there is an elevation which shows that some of this air is directed through the motors and out into the room, while the remaining quantity of air is allowed to escape from the basement around the foundation of the motor generators up into the main room. It may be stated here that one fan is sufficient to take care of ventilating both horizontal and vertical roll motors. In case of trouble with fan A, then the fan B may be used to direct the air to the mill motors. Under normal conditions, however, the fan B will be discharging into the basement and this air will then find its way up into the main motor room through the various openings in the foundations around the motor generators.

In the case of the motor generators, volute housings are used on each of the 3000 kw generators, as well as ducts provided for the induction motor, so that all of the air required by these machines is gathered from the room, and is discharged into a tunnel which conducts the air to the out of doors. In this way the flywheel motor-generator serves as an exhauster and helps to get rid of warm air within the station. Fig. 12 shows the arrangement of the volute housings and how the air which is collected by them is conducted to out of doors.

The motor room is also equipped with roof exhausting ventilators, by means of which the warm air is also exhausted from the station. In this particular case, the heated air from the mill motors is liberated into the room, which raises the ambient temperature of the station. An improvement, however, can only be had by reversing the flow of air through the motors to use the down draft system of ventilation similar to that applied to the motor generator.

Fig. 12—Section through motor generator showing how the air gathered by the generator is conducted through ducts and discharged to the out of doors, for a 40" Universal Slabbing Mill.



DISCUSSION

PRESENTED BY

F. O. SCHNURE, Superintendent Electrical Department, Bethlehem Steel Co., Sparrows Point, Maryland

J. H. HUCKER, American Air Filter Co., Philadelphia, Pa.

J. C. REED, Electrical Engineer, Bethlehem Steel Co., Steelton, Pa.

W. G. McDONALD, Westinghouse Electric & Manufacturing Co., Philadelphia, Pa.

F. O. Schnure: There has been quite a bit of discussion this evening on the means of ventilating electrical equipment and I doubt if I can add much to the subject. Of course, anyone who has been in the steel business for the past fifteen or twenty years knows the progress that has been made in the art of ventilation. The early rolling mill motors used the water spray coolers and air washers, which as a type were subject to rapid deterioration. At Sparrows Point we followed the cycle of development, first—the water spray air washer, then—the hand cleaned filter of the viscous oil type, and later—the self cleaning continuous screen of the same type, until we arrived at the present stage of water cooled recirculated air.

Now, the handling of the situation at the Lackawanna plant as described, is really about the last word in ventilation. We may come, as has been suggested, to a water cooled frame but I also feel that there is some danger in that scheme. However, to water cool the frames, first of all an abundance of good water is necessary. At Sparrows Point we have an abundance of salt water, (about half salt), that gets up in the summer time, for at least a month, to 85° Fahrenheit, and our salt water system is so laid out that this water first goes through our turbine condensers and in the summer time attains a temperature of 100°, which outlaws it for further use in cooling motors. Fortunately, in this cold strip mill, we require about 800 gallons of fresh water per minute for mill use. Our fresh water supply is from artesian wells from two hundred to four hundred feet deep, pumped by deep well pumps and it comes up at about 62° which makes it ideal for use on this particular mill.

About a year and a half ago, one August day, I went out with a thermometer through the various mills just to see what the temperatures were. The mills were working fairly heavy. The outside air was about 86° in the shade. Some of the motor room temperatures registered as high as 115° Fahrenheit, with the air about three feet from the stator frame, and in the ventilating stream from same at about 150° F., and we commonly assume that the temperature of the insulation in the slots is fifteen, possibly twenty degrees higher.

Now, when you go back to a curve drawn by Dr. Steinmetz, on the effect of temperature on the life of insulation, which was published in the A.I.E.E. journal several years ago, we find the expected years of life of insulation at 100 degrees Centigrade, is around ten years and drops very fast, at 110 degrees, being about two years and at 140° C., three or four weeks.

We are trying to improve the life of our insulation and also eliminate as many of our electrical troubles as possible by keeping dirt from the windings.

Returning to the discussion of air systems while the re-circulating system seems to be the best, there are many new installations on which it cannot be applied because of a lack of cooling water and on many old systems space is not available even though the water might be obtained. The travelling screen viscuous oil type filter then seems to offer the best cleaning medium but some inexpensive method should be provided with it to continuously filter the cleaning oil.

J. H. Hucker: I have had a little something to do, in a rather meager way, on some of these electrical installations. Personally, this has been a most gratifying meeting to me for it has been a rather extensive education, so far as the application and the whole picture and layout of the equipment used is concerned. In a number of installations shown we have been fortunate enough to have furnished some of the accessory equipment. I don't know of any further comments I might add as the speaker has well covered the use and limitations of air filters in this particular application.

One point that you are undoubtedly familiar with and worth mentioning, in connection with the enclosed recirculating system, is I believe that it does cut down the possible fire hazard by the elimination of a lot of outside air being circulated. That is somewhat against filters perhaps, but nevertheless I might bring that point out for you, although you are familiar with it.

Now just one other little figure that I have in mind that might possibly be of interest, to you gentlemen. regarding the amount of dust in the air in these mills, Tests made in the various mills by our company show about two and a half grains of dust per thousand cubic feet, in the average mill room, and that is a lot of dust. It is unfortunate that air filter equipment cannot get the last two per cent of dust out (of the air supply) but it just cannot be done; and I might say that we personally are rather glad that a good supply of 70 degree water is not available to all the steel mills.

J. C. Reed: I think I have heard more about hot air tonight than I ever have heard before. Of course I do not mean to insinuate that what I have heard is hot air.

When it comes to cooling rolling mill motors, I agree that the first step in that direction is to take the heat from the coils and put it into the contacting air. I think that is fundamental. Now what is to be done with this hot air? That is the next problem. In the

first place, I do not think that there is any serious problem in the cleaning of the air. Even the old spray cleaners do a fairly good job and I am inclined to think that viscous types of filters do a good job.

There is a very great advantage in circulating the air and using the same air over again, because it gets clean and it stays clean. It seems to me, however, that the big problem is in the cooling of the air. We were shown a few lines going (up and down), indicating a cooler. I would like to know a little more about the details of these coolers.

You might be able to use a very small diameter pipe and put the water which is in Lake Erie through it and be moderately successful. You might even be able to put the water in the Atlantic Ocean through it and be successful. But you can't put the water of the East Branch of the Susquehanna River through it all all. You will be fortunate if you succeed in passing this water through an inch and a quarter pipe for a period much in excess of six months without cleaning out the pipe. Besides, a cooler constructed out of an inch and a quarter pipe gives a very small amount of cooling surface for the amount of material used in its construction and the amount of water used in its operation.

Now we come to the next problem. Why wouldn't it be a good idea to use the same supply of water– This leads back to the same principle of cooling as used in an automobile: there is a supply of clean water and the same supply is used over and over again. If air is cleaned, the same supply of air is used over and over again. The only function of the water is to be able to put it through some type of cooler which will give a sufficient surface to permit cooling to be done by air.

It is necessary to put the heat into one of two places, either into the air—in which case the whole outdoors disposes of it—or into the water which will carry it into the sewer. Neither of these methods is practical unless the air is cool enough to start with, or unless the water is cool enough. I think it is seldom that you will find that the air is not sufficiently cool if there is a large enough surface so that the temperature of it can be raised a few degrees; and that it is possible to get the desired temperature if enough air is used.

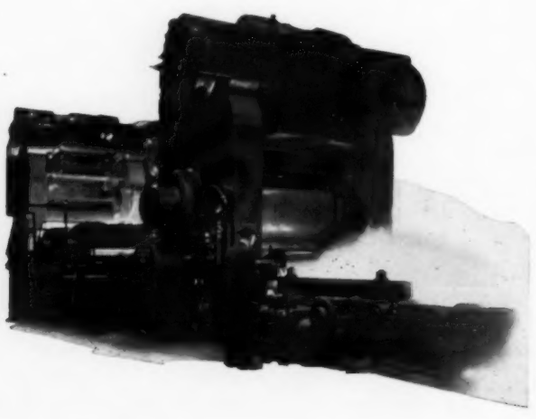
My experience with water coolers at the Steelton Plant has not been at all satisfactory; water coolers used on a liquid slip regulator were not satisfactory; water cooled coils in water-cooled transformers were not satisfactory, in both cases due to the stoppage of the cooling coils. I think there are many steel plants that have the same problem as we have. When you consider that we get the sewage from all the cities on the Susquehanna—Elmira, Binghamton, Scranton, Wilkes-Barre, Sunbury, and Harrisburg—together with the coal mine waters of about ninety per cent of all the anthracite region, you haven't a very desirable source of water, especially in the summer time when the river is low. The water looks like ink and it certainly is not fit for going through any very fine passages in a water cooler, and large coils will not give a sufficient cooling surface.

If the water is not cool enough and if the air is not cool enough, then you must resort to some type of artificial refrigeration. I had rather expected to hear something about that here tonight, since I thought that was the up to the minute way of doing things.

Wm. G. McDonald: As far as Mr. Reed's question is concerned, about the operation of fin type surface coolers with dirty water; it is very important that the velocity through the tubes be high enough so that you get a turbulant flow, or a cleaning action, in your tubes. Otherwise, in a short time, the tubes will fill up with dirt and the rate of heat transfer will be greatly reduced.

Now the matter of utilizing the same water, as Mr. Reed mentioned, that involves a problem of economics. It would be a matter of whether or not it would be more economical to put in refrigerating equipment to cool the air, rather than to attempt to cool the water also. So each installation requires a study, to determine which is the most economical method of cooling.

Now, assuming that we had a small supply of clean water that we wanted to use over and over again, and assume we have some steam available for operating steam jets. We can cool that water to a temperature of say sixty degrees F. and pass it through the surface type coolers and get a very efficient means of heat transfer. So there are many ways of solving the problem.



STEEL GREETS OIL . . .

By WILLIAM A. IRVIN, Pres.
U. S. Steel Corp.

Presented at the opening of the Ninth International Petroleum Exposition, Tulsa, Oklahoma, May 16, 1936

▲ I AM HONORED indeed in being invited to address this meeting which marks the opening of the Ninth International Petroleum Exposition. I am honored further in being invited to address this gathering of men who are the driving force of an aggressive and, in many respects, a young industry. It is inspiring, under the sunny skies of this great State, to look at the smiling faces of friends, most of whom are members of this progressive and all-important industry.

It is a privilege to have this wonderful opportunity to visit with you and to see much of the technical and mechanical improvements relating to the industry which this exposition has in store. I am sure the week to come is one which you all look forward to with joy and enthusiasm. From Tulsa, Oklahoma, and the Great Southwest, will go out waves of enthusiasm and optimism, messages of courage and cheer and that incentive to the world that comes from good deeds well done.

The old story of the meat packing industry to the effect that the "squeal" is the only part of the hog left after processing, has been topped by the oil industry. A "squeal" left in their finished product would be disastrous. Industry may do some squealing, but it is not from the lack of lubrication furnished by you.

It was a surprise to me to find that the State of Oklahoma produced 11¼% of the world's crude oil in 1935; and Texas and the Gulf Coast produced over 26% in the same year—that is, together these two districts produced over 37% of the total world's production. No wonder the Ninth International Petroleum Exposition is held in this neighborhood, and I should imagine you might properly lay claim to the next one.

For many years we have been told, from time to time, that the resources of petroleum will, in a few years, be at the exhaustion point. This point seems to fade farther and farther into the dim distance. The prophets of disaster failed to take into account the resourcefulness of your industry, and the changed conditions brought about by your efficiency. Today it would seem that you are suffering more from superabundance of possible production than you are from scarcity.

It is hardly necessary to assure you that a member of the steel industry feels quite at home in your midst. I hope you will pardon me if I mention the steel and oil industries together but they seem to be inseparably related, and one dependent on the other. We are proud of the place we have had in the development of the oil industry. You have added another and deeper layer of the earth's crust to your field of operation and for the accomplishment of this have demanded better tools and better steels. I talked the other day with men who drilled the first well in the Kettleman Hills; a dry hole, because in those days the limitation that steel and machinery placed upon the depth of drilling would not permit that rich storehouse to be tapped. You gentlemen, in pursuing your activities, have buried more steel than any group of men in the world and, in so doing, you have contributed materially in keeping the steel industry alive and active. May you continue to bury steel, ton after ton. Both industries occupy high places in the world's social and industrial life, and can be well proud of their services to humanity. It would be sad to picture world conditions today had no iron ore and crude oil been discovered and methods devised for the use of these two natural resources for man's benefit.

WILLIAM A. IRVIN

There has been a great span of hardships, failures and successes from the Drake Discovery well of 1859, with its depth of less than 70 feet and its daily production of about 25 barrels, to the present well of upwards of 13,000 feet in depth and to annual production of more than one billion barrels.

In 1850, S. M. Kier of Pittsburgh became the first oil refiner having distilled small quantities of petroleum which came from his salt wells near Kittanning, Pa. In 1854 took place the first leasing of land for oil; a Dartmouth College graduate, Mr. Bissell, leased from Mr. Brewer a part of his farm near Titusville, Pa., and paid for a 99 year lease thereon $500. in cash and a note for $4500. It was the first leasing of land for oil that was the basis of the first oil company in the world, the Pennsylvania Rock Oil Company, formed also in 1854. A few years later in 1858 Col. E. L. Drake

entered the picture and in August 1859 completed drilling the first oil well, having struck oil at a depth of 69 feet. Since that time many have been the bold and adventurous men who have staked their all in drilling for oil, some have lost but, as you well know, many of them were successful beyond their fondest hope. The story of oil has always been to me one of absorbing interest and of inspiration.

Much of the delightful romance of the early oil industry surrounds the pioneering efforts of men to locate productive fields of the so-called "Liquid Gold", and the sending of steel underground to bring it to the surface. The era of early romance has been superseded long since, by the age of technical wonders. Oil, together with natural gas, and steel have continued to go along daily as inseparable companions, starting their contact in the deep strata of the earth's crust and proceeding through pipes, tanks, and stills, to more and different pipes and tanks, arriving finally at the point of consumption. Even there the association is not ended;—Steel needs oil as oil needs steel,—but that is another part of the story. Suffice it to say that the intimacy of oil and steel is based upon the real assistance each can render the other,—a mutual indispensability that confers benefits upon both.

In point of years the petroleum industry is still young. Truly enough, crude mineral oil in small quantities was known to the ancients, a mysterious substance exciting much curiosity and some reverence. Even within the past century petroleum in one form or another was peddled in this country as an Indian remedy, and in the interim, oil has made Oklahoma Indians rich.

Sometime within the decade, immediately preceding the year 1860, there germinated in one of the eastern states an activity which, from the standpoint of modern definition, should be recognized as the beginning of the oil industry in America. That was less than eighty years ago, as man measures time,—but what an epoch has followed it.

The comparatively brief history of your activities is replete with the exhibition of those qualities which have made American enterprise the envy of all nations. Courage, foresight, ingenuity, perseverence, and skill have accomplished in eighty years what lay dormant for untold centuries.

Every "oil man" has reason to be proud of this accomplishment. Every citizen should be glad to accord it full credit, in recognition of the fact that human endeavor is the active and predominant factor in rendering natural resources valuable to all of the people.

We of the Steel Industry derive some satisfaction from the knowledge that our products have lent a progressively helping hand to the Petroleum industry in the attainment of its present goal.

The difficulties of lifting oil from great depth have been overcome by the engineering forces of the oil industry, and with their help, the research and engineering forces of the steel industry have been able to meet the requirements in products of steel which have had to take increasingly heavy stresses, with many other conditions incident thereto.

The refinery branch of your industry has taxed the resource of the steel metallurgists, and we like to think that we have been able to keep pace with your requirements for stronger steels, for steels strong at high temperatures and for steels resistant to corrosion. Your requirements have been a stimulant to our metallurgists in the development of special purpose steels that will find use in many other industries.

Consequently, the implements and metals in use today are not the implements and metals of 1860. Some of the latter are to be seen at this exposition as museum pieces, relics to which a highly sentimental value is attached, but particularly interesting decause of the contrast they afford with the materials and devices now placed at your disposal.

Progress made throughout eighty years in the art and science of the prospector, driller, transporter, and refiner has been met with progress in the art and science of his suppliers. A forward step by either party has meant a forward step by the other.

In these years, as the oil industry prospered and new fields were developed, drilling went deeper and deeper, requiring better steel and equipment, raising problems involving such characteristics as strength, hardness, workability, and resistance to corrosion, abrasion, and fatigue.

The resources of engineering, metallurgy, chemistry, and the allied sciences have been used unreservedly to produce steel properly adapted to the severe and diversified requirements of the oil field, pipe line, refinery, and media of distribution. It is a far cry from the few simple grades of steel and iron of the 1860's to the rather formidable list of carbon and alloy steels of the present day, but we are striving to keep in step with the rapid pace set by our friends who are depending upon us for new and better materials for new and better results.

In all phases of the oil business we see a persistent urge toward a continual improvement of ordinary methods. There is also a determined effort to devise and adopt procedures which bring about major changes in the outlook.

The commercial development of the cracking process is only one of a series of measures brought forward by the industry in the interest of using its raw material to the best advantage, and of thus contributing to the economic welfare of the country. This development, like many others, brought attendant problems to the doorstep of the steel-maker.

These considerations, along with wells twelve thousand feet deep, intricacies here and refinements there, furnish inspiration rather than discouragement to the experts who are working with oil and steel. We learn that not only are new processes for breaking down petroleum, such as cracking, in successful operation, but that synthetic processes for building up certain products are yielding to the ingenuity of your technologists.

So all-prevading has the spirit of analysis and synthesis become that even a customer of the oil industry, stopping at a filling station, is made aware of the fact that the price of gasoline is composed of three major constituents, specified as the stipulated price, plus Federal and State tax.

Herein resides one of the troublesome factors affecting industry today. Unfortunately the tried and true

measures of inventiveness and efficiency seem sometimes almost unavailing against the burdens of excessive taxation. Such problems require external treatment by remedies which lie beyond the limits of these remarks.

Thus far we have emphasized, as befitting this occasion, the happy and mutually advantageous interplay of effort within one pair,—oil and steel; however we know that the situation is strengthened by the addition of other related groups.

Internal combustion engines in motor vehicles, airplanes, ships, homes, and factories have opened up new markets to both oil and steel.

The oil burner in a dozen different fields surpasses the kerosene lamp and other past consumers of certain fractions of petroleum. Roadbuilding is a many sided activity that has meant much to our respective interests, as well as to others. Solvent naphtha and lubricating oil are in demand as never before, on account of new and expanding requirements in various lines of manufacture.

Having traveled the road thus far together, may we continue along this highway of cooperation, facing new problems, overcoming obstacles, working as a unit to keep American industry at the head of the procession. Our industry gains by the progress in your own.

I would be remiss were I to close without acknowledging the contribution that your products, in their various forms, have made to our own developments. Many of our new mills could not have been designed and operated without the development of better lubricants by your chemists and engineers.

It is a satisfaction indeed to have taken a small part in the opening of this great Exposition that marks the mutual progress of our two great industries.

Sheet and Strip Output Last Year

WAS HIGHEST IN HISTORY

Sheet and strip steel production during 1935 was the highest in the history of the steel industry, according to the American Iron and Steel Institute.

Combined output of these products last year was 7,823,146 gross tons, 45 per cent higher than 1934 production, and above the previous record sheet and strip output of 7,757,791 gross tons in 1929. Sheet steel production last year amounted to 5,175,557 gross tons, and 2,647,589 gross tons of strip were produced.

The high production record reflected greatly expanded sales of automobiles, refrigerators, washing machines, farm equipment and other products in which sheet and strip are used. Development of all-steel automobile bodies and refrigerator cabinets was also an important factor in raising sheet and strip production to the new high level.

In the ten-year period 1926-1935 the ratio of sheet and strip production to the total output of finished steel has more than doubled, the ratio being 32.6 per cent in 1935 compared with only 15.4 per cent in 1926.

Almost 80 per cent of the sheet and strip steel which can be traced to ultimate destination goes into products bought by individual consumers.

More than 60 per cent of the combined sheet and strip output goes into automobiles, while 4.5 per cent is used in furniture and office equipment.

Farmers consume nearly 4 per cent of the sheet and strip production in the form of farm implements and roofing and siding for farm buildings.

Household appliances, including refrigerators, washing and ironing machines, kitchen cabinets and utensils, account for more than 9 per cent of the output.

Only a little more than 20 per cent of the production of sheet and strip steel goes into products which are not bought directly by individuals for their own use. This part of the total output goes to railroads, public utilities, ship and barge builders, machinery manufacturers, and the like.

ASSOCIATION ACTIVITIES

PITTSBURGH DISTRICT SECTION

Golf Party

TUESDAY AFTERNOON, JUNE 23

SOUTH HILLS COUNTRY CLUB

H. G. R. BENNETT, Chairman

Golf and other sports in the afternoon.

Dinner and entertainment in the evening.

MAKE ARRANGEMENTS TO ATTEND

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

New Members

O. F. DUFFIELD,
Sales Engineer,
Westinghouse Elec. & Mfg. Co.
Philadelphia, Penna.

R. J. GEISLER,
District Manager,
Ready-Power Co.
Chicago, Ill.

H. L. HILDENBRAND,
District Agent,
The Esterline-Angus Co.
Pittsburgh, Penna.

H. G. REICHARD,
District Manager,
Combustion Eng'ing Co., Inc.
Cleveland, Ohio

E. J. HETH,
Sales Engineer,
Helwig-Speer Co.
Chicago, Illinois

E. J. HULL,
President,
Trabon Engineering Corp.
Cleveland, Ohio

H. C. MULLINGS,
Foreman Electrical Department
J. & L. Steel Corp.
Pittsburgh, Penna.

W. H. BROWN,
Ch. Electrical Engineer,
Keystone Steel & Wire Co.
Peoria, Ill.

G. C. EHEMANN, JR.,
Mechanical Engineer Maint.
Carnegie-Illinois Steel Corp.
Duquesne, Penna.

F. S. ECKHARDT,
Bethlehem Steel Co.
Hamburg, New York

WM. LINTERN, JR.,
Secretary,
The Nichols-Lintern Co.
Dover Center, Ohio

J. R. PATTERSON,
General Manager Sales,
Mackintosh-Hemphill Co.
Pittsburgh, Pa.

L. B. ROSSEAN,
Sales Engineer,
General Electric Co.
Ardmore, Penna.

H. N. PENDLETON,
Skelp Mills Superintendent
National Tube Co.
McKeesport, Pa.

F. E. ROBINSON,
Engineer,
American Steel & Wire Co.
Shaker Heights, Ohio

OTTO L. WEBER,
Drafting, Electrical Department,
Carnegie-Illinois Steel Corp.
Gary, Indiana

F. W. LORIG,
Ch. Draftsman
American Steel & Wire Co.
Cleveland, Ohio

W. G. WITHINGTON,
Sales Engineer,
General Electric Company
Baltimore, Md.

LOUIS MARDAGA,
District Manager,
Bury Compressor Co. &
Staynew Filter Corp.
Pittsburgh, Pa.

D. A. WARSTLER,
Electrical Engineer,
McLouth Steel Corp.
Detroit, Mich.

STOCK ROOMS FOR MAINTENANCE

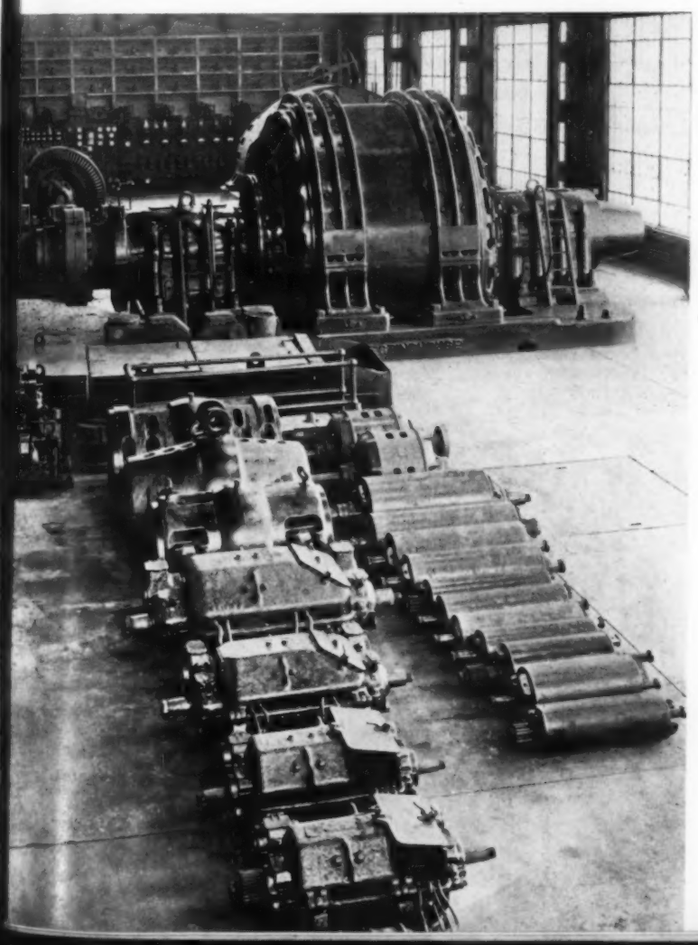
THEIR IMPORTANCE IN THE STEEL INDUSTRY

By F. O. SCHNURE, Supt. Elec. Dept.
Bethlehem Steel Company
SPARROWS POINT, MD.

Paper presented before the Philadelphia Section, Association Iron and Steel Electrical Engineers, April 4, 1936

▲ UNINTERRUPTED and efficient maintenance service depends to a large extent upon the coordination of stores and spares service. In a steel plant that has had "growing pains" for nearly fifty years, where 7,500 motors and 300 cranes are exercised sufficiently to require nearly three-tenths of one per cent of all the power used in the Country, the storekeeper's job approaches a cross between a curator of an antique shop and a director of a modern museum. Many of the original mills and cranes are ambling along with the same old motors, modernized perhaps by later day control, and their job is still important in the general scheme, hence spares and parts must be on hand for ready replacement.

Practical storekeeping demands three important things, first, adequate space whether it be in drawers, bins, shelves, racks or rooms, where an orderly stock can be maintained which will be easily accessible day or night; second, a card index system which will indicate storage location, weights, unit costs, quantities required per year and all detailed information necessary for re-ordering; and third, the minimum of stock in dollars and cents.



The illustration at the left shows how motors applicable to definite locations and armatures of each size in general use are stored in the mills which they protect. The armatures are kept in steel cylindrical enclosures as a protection from dirt and abuse. Spare coils and parts for the main motor and M-G sets are stored in the large steel boxes.

How many items of miscellaneous electrical parts will be required to keep the wheels rolling in this fifty year old plant? The average mill type or industrial D.C. motor may require a stock of around 35 items, without counting the 27 different parts of the conventional mill type brush holder. The average A.C. motor will require fifteen or more, without considering the many unit parts that constitute a set of coils. In this fifty year period, both the D.C. and A.C. motors have been re-designed four or five times so that we have that many times the different frames, types, speeds and horse-power ratings to service. It is impossible to continue with an old line even if there were no gain in efficiency because when a certain type of motor goes out of current production, usually two of the recently superseded motors will cost about the same as three new ones and the delivery will be longer. Therefore, this plant may have one thousand different motors. If there was no duplication of parts, and there isn't very much, parts for these might approach 25,000 items. Two thousand five hundred more would cover the cranes and one thousand or more would cover the castings, forgings and miscellaneous articles and parts not carried in general stock.

As a matter of fact, this is about the total number of index cards required to cover all motors, control, crane parts and general supply stock so it follows from experience that perhaps only 60% of the total component parts require regular replacement.

At first, one might think that this formidable number of parts would require a considerable part of the plant as storage space but it must be remembered that many items are small, such as controller or relay parts, yet important in the general scheme, even as of old when—"For the lack of a nail, the shoe was lost; "for the lack of a shoe, the horse was lost; for the

Above is shown the storage of wire and miscellaneous material.

lack of a horse, the king was lost; for the lack of a king, the kingdom was lost—and all for the lack of a nail."

A double storage tier of shelves three feet by twelve feet, equipped with drawers, size six inches by fifteen inches by five inches, with partitions, could store over 5,000 small items. Usually such a tier can also be arranged to provide from one hundred to four hundred spaces which allows adequate space for individual contactor coils, resistance tubes and general material. Perhaps in all, 7,000 partitioned drawers, bins and shelves will be required for the 15,000 or more parts.

A room thirty-five feet by one hundred feet will provide all the space necessary for the general material, motor and control parts, exclusive of the more bulky gears, pinions, brake wheels, pulleys, armatures, etc. which are more difficult to store and will require, in one form or another, almost as much space. Rough forgings and castings can be kept in an outside yard and finished shafting, wheels and parts are usually stored in the mill they protect.

All of the above must be carried in a stores account that turns over in three or four months, consequently it develops that the larger and more expensive items, especially if they find infrequent use, are considered as spares and charged directly to definite jobs. Others, that have more general application such as commutators which have long shelf life, are depreciated to scrap value after a definite period.

The only way to control this account and at the same time afford protection to the plant, is to use the information on the card index system as a basis for determining the quantities when ordering replacing material. This means that material must be ordered frequently and in comparative small quantities. During ordinary operation, two hundred requisitions covering twelve hundred items will be issued per month for materials not manufactured in our own plant. On the disbursing end, withdrawal orders will average one hundred per day, covering four hundred items.

The storekeeper has an interesting job. However, in his two fold efforts of trying to keep his stock up with a minimum inventory in dollars and cents, he could find ready use for an "anticipator", the crystal gazer's gadget that foretells the future and which all steel men would like to possess.

THE GREAT PITTSBURGH FLOOD

HOW IT AFFECTED U. S. STEEL SUBSIDIARIES

▲

Report Compiled by Subsidiary Companies of U. S. Steel Corporation

▲ CONTINUOUS heavy rains for almost 48 hours throughout the water-sheds of the Allegheny and Monongahela rivers and their tributaries caused both rivers to begin to rise on Monday, March 16th. The Weather Bureau issued flood warnings to the entire district but indicated that the height of the flood would probably not exceed 32 to 33 feet. On Tuesday, March 17th, word came that Johnstown was threatened with a disaster much worse than the great flood of 1889. The rise of the flood was exceedingly rapid and there was 18 feet of water in the business district and many bridges had been wiped out. The reports of death and destruction from Johnstown spread fear throughout the Pittsburgh District. The Weather Bureau then predicted about 34 feet at the Point. By midnight, however, the flood had reached a stage far beyond the point predicted and at noon on Wednesday had attained a height of 46 feet or 8 feet above the highest stage previously recorded.

On Wednesday morning, the entire Pittsburgh District was in the grip of the greatest flood in its history. The City was without electric power and there were no lights and little heat. Business was at a standstill. All ordinary forms of transportation had ceased and the great buildings and stores in the business district were closed. A complete failure of the water supply was also threatened. The police were unable to cope with the situation and the State Police were called and the National Guard was mobilized.

The great plants of the Subsidiary Companies of the Steel Corporation, located in the valleys of the Monongahela, Allegheny, Ohio, Conemaugh and Kiskiminetas rivers, were seriously affected by the flood. The plants had been put in shipshape to withstand the highest stages previously known, but as the water crept up and up far above any previous mark, many of them were completely submerged and others were badly crippled.

Some plants located on higher ground, such as Donora Works of the American Steel and Wire Company, National Works of the National Tube Company, Clairton Works and Duquesne Works of Carnegie-Illinois Steel Corporation were not directly affected. While flood waters did not reach the yard level of Homestead Works, they did attain a height that required shutting down, for a short time, all producing and rolling units.

The plants most seriously affected by flood waters were the Vandergrift Plant of the American Sheet and Tin Plate Company, Rankin Plant of the American Steel and Wire Company, Edgar Thomson Works, Carrie Furnaces, Schoen Works, Isabella Furnaces, Mingo Works and the Lorain Plant of Carnegie-Illinois Steel Corporation, Ambridge Plant of the American Bridge Company and Pittsburgh Warehouse of Scully Steel Products Company.

While all these great plants were completely submerged, they managed to resume at least partial operations within a surprisingly short time after the flood receded.

The prompt rehabilitation of the plants and the rapid resumption of operations have been among the most outstanding features of this great disaster. With one or two exceptions, all plants are today operating as usual and even during the period of the flood were able to accept and fill their orders. This condition is entirely due to the loyalty and devotion to duty of every employee from the highest to the lowest. The stories of the men who worked long hours under the most trying circumstances, often in water up to their waists, to save valuable equipment and prevent the ravages of the flood are so numerous that it would be unfair and ungenerous to single out any individual or groups of individuals for special mention.

On of our Executives has said:

> "This writer cannot bring himself to close this report without a tribute to the Lorain Division organization. The resourcefulness and fortitude with which they have met this emergency—supervisors and men alike—are beyond all praise. The subscriber acknowledges himself proud and vain of his association with the men who have done these things and carried on, regardless of their own comfort and well being."

Our employees were not only active in protecting our plants, remaining at their posts of duty until ordered to leave for their own protection, but were also instrumental in saving the lives of many who were marooned in their homes, often with great danger to themselves. They also added to the comfort and welfare of the less fortunate by generaous contributions to local relief agencies and the Red Cross.

At Vandergrift, where the loss was unusually heavy, 111 houses were washed away by the rushing waters of the Kiskiminetas and 200 additional houses were moved from their foundations and badly damaged. More than 1500 people were homeless and in dire need of relief. The Employee Representatives of Vandergrift Works of the American Sheet and Tin Plate Company contributed $125.00, the entire amount in their

treasury, for relief, and their fellow employees at Farrell, Monessen, New Castle and Shenango sent many truck loads of food and clothing. There was a great shortage of cots and bedding in the district. A large quantity of such material was stored in a building at Edgar Thomson Works, surrounded by 8′ of water at the height of the flood. As soon as the flood receded sufficiently to permit entrance into the building, many salaried employees and office workers volunteered their services, working all night to sort and ship the material. Much of it was sent to Vandergrift, where the need was unusually great. The Edgar Thomson Works supplied to the Red Cross 68 truck loads, including:

1777 steel cots
1368 mattresses
1950 blankets
1405 sheets
1821 pillows
204 pillow cases

These are only two examples of the spirit of courage and helpfulness which prevailed among our employees during the entire emergency. Like instances could be multiplied a thousand times over.

The same spirit which was manifested in our plants, prevailed among our employees in the General Offices in Pittsburgh. While the Frick Building, due to lack of power, heat and light, was closed for several days, the Corporation Companies located in the building established temporary quarters at the University Club, the William Penn Hotel and elsewhere and carried on their work under the greatest possible handicaps.

The Carnegie Building was dark and cold and without elevator service and in spite of the lack of usual transportation facilities to and from their work, hundreds of employees reported for work each morning and eagerly volunteered their services. The telephone operators worked long hours at their switchboards, getting through to our plants and other points wherever possible. It was a real privilege to observe the skill and ingenuity with which they operated. The Order and Shipping Bureaus continued to keep the mills scheduled, working without light and heat. Some little relief was finally given by the temporary installation of gas stoves. Thousands of candles, lamps and lanterns were purchased and distributed where most needed. The Operating Officials, working night and day, established headquarters on the second floor of Carnegie Building and kept in touch with the plants and their operations. When telephone communications failed, an auxiliary operating headquarters was established at Homestead Works to take advantage of the inter-plant communication system. This system made possible the closest co-operation among the plants of the Company in the Monongahela Valley, one plant helping another, often at great sacrifice to its own interests.

While the Subsidiary Companies of the Steel Corporation have suffered most severe losses in Plant and equipment, they have, nevertheless, contributed the generous sum of $25,000.00 to the American Red Cross for flood relief in this district and also made many other contributions to local relief committees.

The emergency has passed, great losses in Plant and equipment have been sustained, but the morale and

An interesting view of Carnegie-Illinois Steel Corporation's Edgar Thompson Works, at Braddock, Pa. under 6 feet of flood water at Furnace "F", March 18, 1936. Note the steam rising from the cinder pit at right.

courage of our employees have never faltered. They were ready and anxious not only to do their regular work but anything that would aid their organization to carry on.

The terror of the rushing waters, the fear of a water and food famine, the danger of disastrous fires and the hardships all were compelled to undergo, will soon be forgotten, but the loyalty and devotion of our employees to their Company and to their neighbors, their spirit of co-operation and will to carry on, will always be remembered as one of the brightest spots in the history of the greatest of all floods in the Pittsburgh District.

A view of Furnace "H" at the Edgar Thompson Works shows how 10 feet of flood water over the roadway completely inundated the vehicle tunnel.

▲ ▲ ▲ ITEMS OF INTEREST ▲ ▲ ▲

John H. Graft, formerly assistant electrical superintendent, Campbell works, Youngstown Sheet and Tube Company, has resigned to accept the position of superintendent of the electrical department, Republic Steel Corporation, Youngstown, Ohio.

Mr. Graft was born at Connellsville, Pa., on April 17, 1897. After graduating from Connellsville High School in 1915, Mr. Graft was employed for three years with the West Penn Power Company, Connellsville, Pa. After spending three more years with the H. C. Frick Coke Company, Mt. Pleasant, Pa., Mr. Graft left to associate himself with the Youngstown Sheet and Tube Company. The past seven years Mr. Graft was the assistant electrical superintendent of the Campbell Works.

▲

L. P. Niessen has been appointed advertising manager, Cutler-Hammer, Inc., Milwaukee, Wis. In his new position Mr. Niessen will have charge of all advertising and sales promotional activity covering the complete line of motor control and electrical apparatus which the company manufactures.

After completing a course in engineering, Mr. Niessen attended Marquette University and later gained extensive experience in the company's products in the sales department and various manufacturing departments. Prior to his appointment he also served for some time as Assistant Advertising Manager.

Mr. Niessen is well known in Milwaukee and national advertising circles, being a past president of the Milwaukee Association of Industrial Advertisers, a former director of the National Industrial Advertisers Association, and a member of the Milwaukee Advertising Club and the Advertising Federation of America.

C. J. Smith, formerly head of the auxiliary departments of the Carnegie-Illinois Steel Corporation, South Chicago, has been promoted to the head of the maintenance department of the Gary works of the same company.

Mr. Smith, an active member of the Association, is at the present time representing the Chicago section on the board of directors.

▲

O. R. Heidenrich, formerly district manager of the Ready-Power Company, has joined forces with Mr. J. M. Hawkins and they are operating under Pennell Engineering Associates handling Elwell-Parker and other material systems in the Pittsburgh area.

▲

J. W. Lewis, who since 1923 has been assistant to President Gerard Swope, was elected treasurer of the General Electric Company at the meeting of the board of directors of the company in New York City on April 24. He succeeds R. S. Murray, who retired on May 1 because of ill health, after 43 years service with the company.

▲

E. R. Norris, who is well known to the machine tool industry, retired April 1, 1936 after 44 years continuous service with the Westinghouse Electric & Manufacturing Company in the manufacturing and equipment phase of their business. At the time of his retirement Mr. Norris held the position of assistant to general works manager.

JOHN H. GRAFT

L. P. NIESSEN

C. J. SMITH

E. F. ENTWISLE

V. J. PAZZETTI

E. F. Entwisle has been appointed assistant general manager of the Lackawanna Plant. He was formerly superintendent of the Saucon Division of Bethlehem Plant. Mr. Entwisle was graduated from Cornell University in 1906, and entered the employ of Bethlehem Steel Company, at the Maryland Plant, Sparrows Point, Md., as mechanical engineer in 1914. He later became successively mechanical engineer at Steelton Plant, general superintendent of the then blast-furnace division of Lebanon Plant, and assistant general manager of Steelton Plant. He came to Bethlehem Plant as superintendent of the Saucon Division in 1928.

▲

J. M. Sylvester has been appointed assistant general manager of the Bethlehem Plant of the Bethlehem Steel Company. He was formerly in charge of the Lehigh Division of this plant. Mr. Sylvester attended the U. S. Naval Academy at Annapolis and after two years in the Navy entered the employ of Bethlehem. In 1921 he became superintendent of forges and foundries, and in 1924 superintendent of the Lehigh Division.

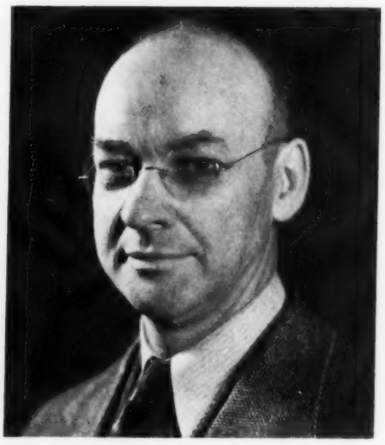
▲

V. J. Pazzetti has been named superintendent of the Saucon Division of the Bethlehem Steel Company, having been formerly superintendent of Open Hearth No. 2 in this division. Mr. Pazzetti attended Lehigh University. He has been with Bethlehem for twenty-three years, and has occupied the positions of melter at Saucon Open Hearth, night-turn assistant superintendent, day-turn assistant superintendent, and superintendent of No. 2 Open Hearth.

▲

J. C. MacNeill, formerly assistant superintendent of Open Hearth No. 2, has been made superintendent of Open Hearths, Saucon Division, Bethlehem Plant, Bethlehem Steel Company. Mr. MacNeill has been with the company for twenty years and was educated at Yale University, being graduated from there in 1915.

J. M. SYLVESTER



J. C. MacNEILL

I. LAMONT HUGHES

I. Lamont Hughes announces his resignation as Executive Vice President and Director of Carnegie-Illinois Steel Corporation, and as President and Director of its underlying companies, which was effective as of April 30.

Mr. Hughes was born at Mercer, Mercer County, January 25, 1878. He received his early education in the public grammar schools of Mercer and New Castle and later came to live with his sister in Braddock, where he attended high school at North Braddock. Immediately after graduating from high school, Mr. Hughes entered the employ of the Edgar Thomson Works of the Carnegie Steel Company at Braddock. He obtained a position in the engineering department under Mr. E. E. Slick, Chief Engineer of the plant.

Mr. Hughes was put to work with the engineering corps, spending part of his time in the drafting room and part in the mill with the rod and chain. In 1901, only four years after he had first entered the employ of the Carnegie Steel Company, Mr. Hughes accepted appointment as head of the drafting room and as assistant master mechanic of the Union Steel Company, Donora, Penna. He remained there for four years and returned again to the Carnegie Steel Company. At that time he was appointed master mechanic of the bar mills of the Carnegie Steel Company in Youngstown, Ohio, his position including the upper and lower mills in Youngstown and the mills at Warren and Girard, Ohio, and at Greenville, Penna. In March, 1906, Mr. Hughes was made assistant general superintendent of the bar mills of the Youngstown district and five years later, in March, 1911, he became general superintendent of these mills. He continued in this capacity until January 1, 1916, when he was made assistant general superintendent of the entire Youngstown district of the Carnegie Steel Company, whose operations at that time included the construction of the modern steel bar mills and townsite at McDonald, Ohio. In June, 1916, he was sent to Canada as general superintendent in charge of the Canadian Steel Company's project at Ojibway, Province of Ontario. Two years later, in June 1918, he returned to the United States and became general superintendent of the operations carried on by the United States Steel Corporation for the United States Government at Neville Island, Pittsburgh, which involved extensive construction work of a projected ordnance plant. When this work was curtailed with the signing of the Armistice, Mr. Hughes was made president of the Lorain Steel Company at Johnstown, Penna., the duties of which position he assumed on May 1, 1919. Soon afterwards, on January 1, 1920, he was made general superintendent of all the operations of the Carnegie Steel Company in the Youngstown District. There he remained for five years and until January, 1925, when he was elected a vice-president of the Carnegie Steel Company, having at that time the distinction of being the youngest of the four vice-presidents. In April, 1928, he was made vice-president of the United States Steel Corporation in charge of operations and also assistant to James A. Farrell, president of the corporation, with headquarters in New York City. When, on August 25, 1930, ill health had caused the resignation of Wm. G. Clyde as president of the Carnegie Steel Company, Mr. Hughes was elected to this office by the board of directors on September 1, 1930. When the Carnegie Steel Company and the Illinois Steel Company were merged into the Carnegie-Illinois Steel Corporation, September 1935, Mr. Hughes was made executive vice-president of the new combine, which position he held until his recent resignation.

▲

E. S. Sawtelle, Vice President and general manager of The Tool Steel Gear & Pinion Company, Cincinnati, was elected President of the American Gear Manufacturers Association at their Philadelphia Annual Convention, April 20. Mr. Sawtelle has been active for many years in the steel industry and has delivered several papers before our Association.

E. S. SAWTELLE

ADVERTISING PAGES REMOVED

C. E. WEINKAUF

C. E. Weinkauf has joined the sales force of the Hodson Corporation and will be located in the newly established Pittsburgh office of this company in the American Bank Building. A graduate of Pennsylvania State College, Mr. Weinkauf has been located in the Pittsburgh District for many years. For six years he was general sales manager of the Royston-Cadillac-La Salle Company. Thereafter he entered the lubrication business, and for four years was a distributor for the Lubriplate Corporation. The Pittsburgh office of the Hodson Corporation will be under the direct supervision of W. D. Hodson, President, assisted by Mr. Weinkauf and E. W. Hodson, Treasurer.

▲

Our attention has been called to a proposition relative to the exchange of a young American with a young German for educational purposes.

The young German in question proposes to secure a position for the young American with a firm in Emmerich, Germany. This Company is a manufacturer of small machines and they offer either office or factory work for a period of approximately one year.

The young German desires work with a medium size American firm, either a bank or work in a small factory. He proposes to make all the necessary arrangements for the young American and in turn would expect assistance from the young American in getting located in the United States.

Mr. Edgar E. Brosius, Sharpsburg Post Office, Pittsburgh, Pa. has further information regarding this subject, should any of our readers desire further details.

▲

J. S. McKeighan, Lincoln Electric Company, has been transferred to the sales staff and is stationed at 1712 Catalpa Drive, Dayton, Ohio, operating under the Cincinnati District Office, located at 5th and Baymiller Streets.

▲

J. B. McCormick, Lincoln Electric Company, has been transferred from the Philadelphia office, 401 North Broad Street to the Pacific Coast, and is stationed at 3160 Montecito Avenue, Fresno, California, under the personnel of the Los Angeles office at 812 Mateo Street.

Paul W. James, Lincoln Electric Company, has been transferred from the factory to 16½ Crandall Street, Binghamton, New York, operating under the Syracuse office, at 517 Erie Boulevard, East.

▲

George A. Neesham, assistant treasurer and purchasing agent of the Wyckoff Drawn Steel Company, Chicago, has just been elected to the vice-presidency of District No. 3 of the National Association of Purchasing Agents. Previous to this past year's service as national director of the N. A. P. A. Mr. Neesham served as president of the Chicago branch of this same association.

▲

∴ OBITUARIES ∴

David W. McFadyen, 61, chief electrician of the Universal Pennsylvania Plant of Universal Atlas Cement Co., died suddenly at his home in East Pittsburgh, Pennsylvania, on May 4. Mr. McFadyen, for 25 years an active member of the Association of Iron & Steel Electrical Engineers, began his electrical career in 1893 in the Garrison Alley plant of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pennsylvania, and remained in their employ for about ten years. He entered the service of the United States Steel Corporation in 1903 at the Clairton Works of Carnegie Steel Company and had been associated with the Universal Atlas Cement Co. since 1907.

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Burton L. Delack, general assistant to Vice-president W. R. Burrows of the General Electric Company and until two years ago manager of the Company's Schenectady Works, died May 7, following a stroke suffered at his office the previous afternoon.

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Claude Bethel, Manager of the Railway Engineering Department of the Westinghouse Electric & Manufacturing Company and a contributor to many important developments in the electric transportation industry, recently died after a week's illness of pneumonia.

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Walter D. Douthitt, general superintendent of the Pittsburgh Rolls Corp., died recently, following a several week's illness. He was 55.

Considered an expert in foundry and rolling mill activities, Mr. Douthitt had spent his entire career in the industry. He was originally affiliated with the old Garrison Foundry, South Side, later becoming associated with the Mesta Machine Corp., as a roll expert.

Five years ago Mr. Douthitt became general superintendent of the Pittsburgh Rolls Corp. remaining in that position until the time of his death.